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ORIGINAL ARTICLES.

I.—On some Fossil Prawns from the Osborne Beds of the Isle of Wight.

By Henry Woodward, LL.D., F.R.S., F.G.S.

(PLATE V.)

THROUGH the intervention of my friend Mr. William Whitaker, F.R.S., I, some time ago, received from Mr. G. W. Colenutt, F.G.S., of Hanway Lodge, Ryde, Isle of Wight, 26 small slabs of Osborne clay, on which are preserved, in a more or less good state (generally less), a series of prawns and small shrimp-like Crustaceans, collected by him from the Oligocene strata, Chapelcorner Copse, between King's Quay and Wootton Creek, just to the west of the Boat-house, on the shore below Binstead House; also on the shore below Ryde House, and immediately to the south-east of Sea View Pier; where (especially at Chapelcorner Copse) extremely interesting exposures of the Osborne Beds may be seen and studied, between the base of the cliff and low-water mark (see p. 99).

These beds formed the subject of a paper by Mr. Colenutt (see Geol. Mag., 1888, Dec. III, Vol. V, p. 358); while the small fishes (*Clupea vectensis*) which occur associated with the Crustaceans were described and figured in 1889 by Mr. E. T. Newton, F.R.S., F.G.S., in the Quarterly Journal of the Geological Society (vol. xlv, pp. 112–117, pl. iv).

Since receiving the above specimens from Mr. Colenutt, I have been favoured with three additional examples, also obtained from King's Quay, by Mr. Reginald W. Hooley, of Ashton Lodge, Portswood, Southampton, who has paid considerable attention to the fossils of the Tertiaries of Hampshire and the Isle of Wight.

The entire series comprises fourteen examples of the larger form (see Pl. V, Figs. 1–4) and fifteen of the smaller one (Pl. V, Figs. 5–7), Figs. 1 and 4 of the former having been drawn from Mr. Colenutt's and Figs. 2 and 3 from Mr. R. W. Hooley's cabinet. The smaller form (Figs. 5–7) is from Mr. G. W. Colenutt's Museum.

Owing to the presence of orbicular calcite and some iron pyrites in the clay, it is often very difficult to detect the details of the structure of these Crustaceans; moreover, in order to preserve them from decay, they have to be treated with a coat of hot gelatine, which, although preservative, is apt to obscure minute details of structure afterwards.

PROPALÆMON OSBORNIENSIS, H. Woodw. (Pl. V, Figs. 1–4.)

Although there is no one example of the large Osborne shrimp which has been preserved entire, nevertheless, by a careful examination of the fourteen specimens before me, I am enabled to arrive at a fairly correct notion of the separate parts, and so of the prawn as a whole.

The general outline of its form may be seen from the examples figured on Pl. V, Figs. 1–4, but no restoration has been attempted.

From Fig. 1 we perceive that the carapace measures 20 millimetres in length (the rostrum in this specimen is injured and indistinct, but is better seen in Fig. 2); the depth of the carapace in profile is 11 mm.; the abdomen ('pleonic somites,' Bate) measures 28 mm. in length, minus the telson, which, although wanting in Fig. 1, is supplied by Fig. 3, and is 10 mm. long; the lateral lobes of the tail-fin being about equal in length, or a trifle longer than the telson. In Fig. 2 the rostrum shows five distinct teeth or serrations; a single spine is also to be observed on the hepatic region of the carapace in Figs. 2 and 4; the bifid flagella of the inner antennæ are preserved in Figs. 1 and 2, but the fragmentary remains of the long outer antennæ are only imperfectly seen on some of the slabs; the long slender ambulatory legs measure 25 mm., they are shown in Figs. 2 and 4. But the first and second long and slender chelate limbs are too imperfectly preserved to be made out satisfactorily, though I believe both of them to be present. The abdominal swimming feet (pleopods) are well preserved in Figs. 1 and 2, and are about 12 mm. in length. The pedunculated eye can be seen in Fig. 2 and also in Fig. 4.

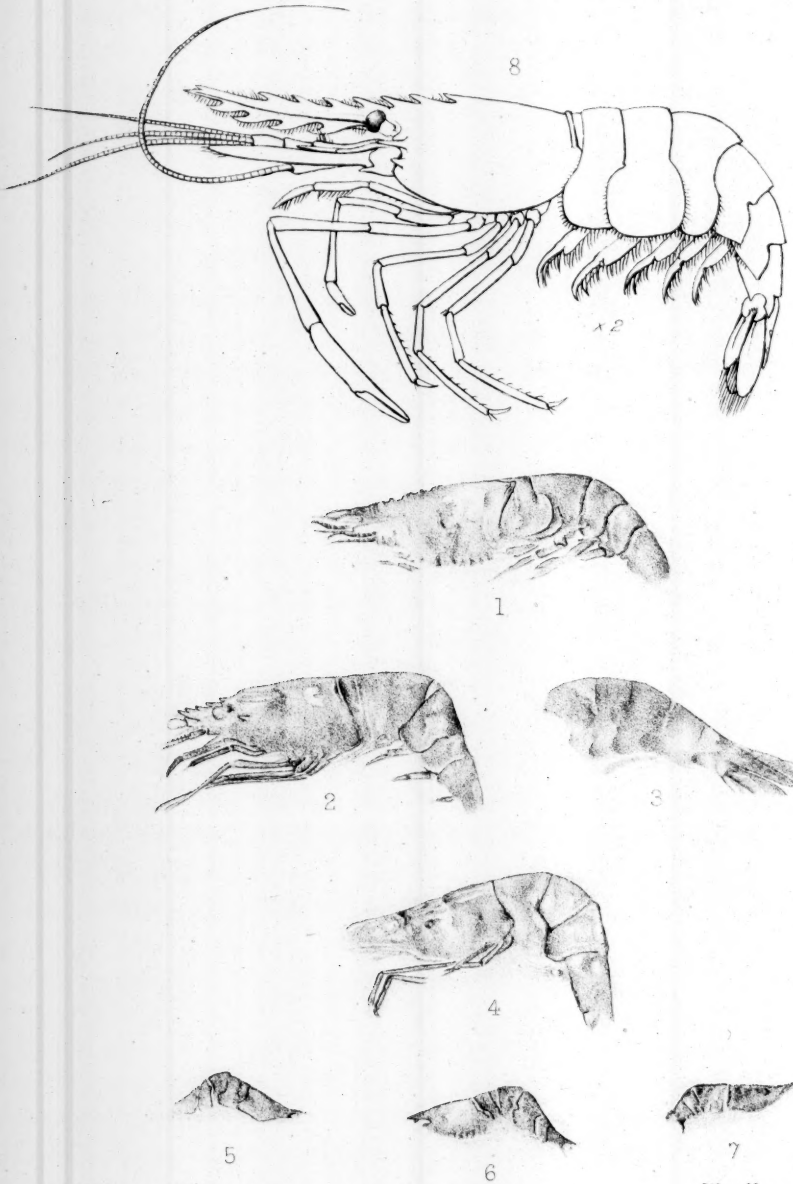
In size this prawn closely agrees with the living *Palæmon affinis*, M. Edw.[1] (Pl. V, Fig. 8), but the rostrum in the living form is considerably larger and more strongly serrated, both above and below. The segments of the abdomen (pleon) in the fossil form closely resemble the living genus, but the pleopods are perhaps somewhat longer in the Osborne specimen.

Having regard to the difficulties of dealing strictly with such imperfect material, I venture to define the fossil form as *Propalæmon*, and for a trivial name I have called it after its locality, *Osborniensis*.

PROPALÆMON MINOR, H. Woodw. (Pl. V, Figs. 5–7.)

This little form, of which fifteen examples have been obtained by Mr. Colenutt, from the same beds as have yielded the larger species (*P. Osborniensis*), measures 26 mm. in length (of which the carapace measures 10 mm., the pleon 11 mm., and the telson 5 mm. The

[1] Fig. 8 is drawn in our Plate of twice the natural size.



G. M. Woodward del. et lith. West, Newman imp.

Figs. 1–7. Fossil Prawns &c., Osborne Beds, I. of Wight. ½.
Fig. 8. Palæmon affinis, M. Edw. (recent) ⅔.

depth of the carapace is 5 mm., and the pleon at the third somite is of the same depth. The appendages are not preserved, nor can the serrations on the rostrum be clearly detected.

This may possibly be a young form of the larger species with which it is found associated, but of that we have no positive evidence before us; it is therefore most convenient to treat it as distinct. Both species occur pretty abundantly in the same bed which yielded the small *Clupea vectensis*, described by Mr. E. T. Newton, F.R.S., and are in all probability either estuarine or marine. The living Palæmonidæ occur, not only in the sea, but also in rivers, in Lake Amatitlau Guatemala, the islands of the Pacific, and one in Australia, *Palæmon affinis*, Pl. V, Fig. 8 (see "Voyage of *Challenger*"; Crustacea, by C. Spence Bate, 1888, vol. xxiv, p. 782, pl. cxxviii, fig. 5). Two genera are British.

In this genus (*Palæmon*) the most striking feature is the elongation of the second legs in the male, which not infrequently even exceed the total length of the animal's body; a specimen of *Palæmon lar* may measure about five inches from the front margin of the carapace to the tip of the telson, and carry limbs eight inches long. (See "A History of Crustacea," by Rev. T. R. R. Stebbing, F.R.S., pp. 246–247.)

The following account (Art. II) of the geology of a portion of the Osborne Beds of the Isle of Wight, whence the fossil Crustacea were obtained, has been most obligingly drawn up for me by Mr. G. W. Colenutt, F.G.S., the first discoverer of the fossils.

EXPLANATION OF PLATE V.

FIGS. 1–4.—*Propalæmon Osborniensis*, H. Woodw. Osborne Beds: Isle of Wight.
FIGS. 5–7.—*Propalæmon minor*, H. Woodw. Osborne Beds: Isle of Wight.
FIG. 8.—*Palæmon affinis*, M. Edw. Recent: Port Jackson, Sydney, New South Wales.

II.—Note on the Geology of the Osborne Beds.[1]

By G. W. Colenutt, F.G.S.

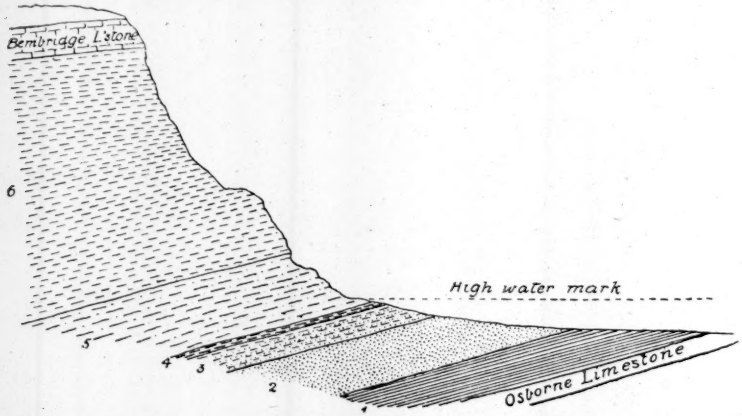
THE fossil shrimps or prawns briefly described in the preceding paper by Dr. H. Woodward occur in the 'fish-clay' of the Osborne Series at Chapelcorner Copse, Binstead House, Ryde House, and Sea View, Isle of Wight, and they were first discovered by me in these beds about the year 1876. Having regard to the fact that new species of fish, etc., have been recently obtained from the Osborne Beds, it would seem that these prawns are very probably also new to English strata.

At nearly all outcrops of these beds the strata yield few fossils,

[1] The following is a list of the papers bearing on the present article:—
G. W. Colenutt, "On the Osborne Beds": Geol. Mag., 1888, p. 358.
E. T. Newton, "On *Clupea vectensis*": Q.J.G.S., February, 1889, vol. xliv, pp. 112–117, pl. iv.
E. T. Newton, "Geology of the Isle of Wight": Memoirs of Geological Survey, 1889, p. 152 et seq.
E. T. Newton, "On *Amia*": Q.J.G.S., February, 1899, vol. lv, pp. 1–10, pl. i.
G. W. Colenutt, "Notes on Geology of the North-East Coast of Isle of Wight": Papers and Proceedings of the Hampshire Field Club for 1891.

but there are some eight or ten feet (vertical measurement) of strata at the base of the upper division of the series (the St. Helen's Sands of Forbes) which are rich in fossils in some localities. In consequence of the soft nature of the clays, retaining or sea walls have been built nearly all the way from Ryde to Sea View, and, unfortunately, as it is here found, generally speaking, a short distance above or about high-water mark the fossiliferous band is obscured by the walls, the outcrop, roughly speaking, being about horizontal between the two places. Only four localities where these beds can be examined are at present known, namely, at Sea View (here often covered up by sand and shingle), at Ryde House (now mostly obscured by an old 'founder' of the low cliff), at Binstead House (an imperfect exposure), and at Chapelcorner Copse, just west of Wootton Creek. This last is by far the best section, and we will take it as representing the others.

The ledge of rocks just above low-water mark is the limestone of the Osborne Series, forming the topmost division of the 'Nettlestone Grits' of Forbes; and tracing the strata in ascending order from this base we have the following series of beds :—



Section showing the succession of the Osborne Series from the Osborne Limestone at the base to the Bembridge Limestone at the top. (Fig. 4 of this section is the bed which has yielded the small *Clupea vectensis* and the Crustaceans described by Dr. H. Woodward.)

Vertical Estimated Measurements.

1. (Bed 6 in my paper, GEOL. MAG., 1888, p. 359.) Dense clay, green and brown mottled, about 4 feet; no fossils whatever, as far as I am aware.

2. (Bed 5 in my paper, op. cit.) A series of clays of fluviatile origin, about 6 feet. At the base is a dark blue or blackish seam, about 2 inches thick, of finely comminuted shells mixed with carbonaceous clayey particles. This seam has yielded bones of *Trionyx*, teeth, etc., of *Alligator Hantoniensis*, bones of *Amia Anglica* (*vide* Mr. Newton's paper), also the jaw of *Amia Colenutti*, scales of

Lepidosteus, many small fish-bones, vertebræ, etc.; and in this seam I have also noticed small dark blue or green pebbles, apparently of flint. The shells are probably *Paludina lenta* and *Melanopsis carinata*, but are almost too crushed to be identified. There is above this most interesting seam about three feet of rather hard stratified dark blue clay, with many seams of *P. lenta* and *M. carinata*, mostly crushed, but some perfect, with occasional masses of iron pyrites encrusting the shells, and also some lenticular masses of grey cement-stone.

3. (Bed 4 in my paper, op. cit.) The clay slightly alters, fewer seams of shells being observed, but at the top of this division, which may be about 3 feet thick, we find many vegetable remains matted together. These are mostly of reeds or sedges, but are not yet identified; occasionally one may find carbonized seed-vessels resembling *Folliculites thalictroides*, but somewhat different in shape, also some much smaller oval seeds; flat leaves of reeds or water plants with roots and rootlets attached, somewhat resembling the living *Zostera*, occur abundantly. All these plant remains are associated with *Paludina* and *Melanopsis*, and are in layers in a somewhat soft grey clay; it is difficult to preserve the plants, as they crack and curl up on drying. Lenticular masses of cement-stone also occur in this division.

4. (Bed 3 in my paper, op. cit.) Immediately above the plant bed occurs the 'fish-clay.' This is a seam of dense, dark greenish grey clay about 7 inches thick, very distinct in character from any of the other clays. It acquires a lighter colour on drying, and when dry assumes a somewhat granulated surface. It is a continuous seam, judging from its appearance at the several sections. It has not been found west of King's Quay, nor is it seen at Whitecliff Bay. The clay has an irregular transverse jointing, and readily separates into rough nodules. It is highly laminated, and easily flakes when split with the point of a knife; it is about as hard as ordinary yellow soap. It is much charged with iron pyrites, in the form of dark gritty masses or lumps in the clay. *Clupea vectensis* and the prawns are found distributed in this seam; the top half-inch of the bed is the best place, however, in which to look for them. The fish are generally in small shoals, but the prawns are usually solitary, though the smaller ones do occur in shoals. No insect remains have as yet been observed.

5. (Bed 2 in my paper, op. cit.) Above the fish bed are several feet of green, brown, and grey clays, of a flaky nature, and on one horizon thin lenticular masses of fish bones, etc., occur. These deposits have yielded remains of *Lepidosteus* (vertebræ, scales, and bones), snake vertebræ, jaws and vertebræ of *Amia Anglica*, teeth of *Theridomys*, *Palæotherium*, *A. Hantoniensis*, bones of *Emys* and *Trionyx*, and quantities of bones and vertebræ of teleostean fish, etc. These are obtained, of course, by drying, scalding, and washing the clay.

6. (Bed 1 in my paper, op. cit.) Above this is about 40 feet or so of the usual mottled unfossiliferous green, red, brown, grey, and

yellow clays of the Osborne Series, capped at the top of the cliff by the Bembridge Limestone.

Judging from the character of the fossils, we seem to be justified in coming to the conclusion that Nos. 1, 2, and 3 were deposited in an estuary, or in a lake, or lagoon near the sea; the mollusca are fluviatile, and so are the vertebrate remains. At the top of No. 3 we have evidences of much plant growth, pointing to a calm lagoon, in which deposition was slow and regular. The fish-clay is puzzling, and we shall probably not be far wrong in assuming that a sudden influx of marine mud caused its deposition. The *Clupeæ* are most probably marine forms, and all the fish appear to have been smothered or asphyxiated, as the jaws are wide open and the fish are quite perfect. It remains to be seen whether the prawns are marine or fluviatile forms. Above the fish-clay we find that the *Paludinæ*, etc., disappear, pointing to much more brackish conditions; the lenticular masses of bones suggest drifting and the influence of deeper water, while further up the mottled red clays decidedly indicate semi-marine conditions of deposition.

In a local series like the Osborne Beds it is not surprising that new forms should be found, especially in a deposit which varies so much in its different outcrops.

III.—Eoliths from South and South-West England.

By the Rev. R. Ashington Bullen, B.A. Lond., F.G.S.

(PLATES VI, VII, AND VIII.)

I. Introduction.
II. Character of the Eoliths.
III. Researches of Blackmore, Westlake, and C. Reid.
IV. Eolithic Localities in the Drainage Area of the Avon.
V. The Dewlish Implements.
VI. Use of Hollow 'Scrapers.'
VII. Description of Specimens figured.
VIII. Bibliography.

I. *Introduction.*

THE labours of Mr. Benjamin Harrison around Ightham, in Kent, have been before the scientific world since May, 1889, when Sir Joseph Prestwich read his now historic paper before the Geological Society "On the occurrence of Palæolithic Flint Implements in the neighbourhood of Ightham, Kent; their distribution and probable age."

This was followed in 1891 by an even more important one, "On the Drift Series of the Valley of the Darent, with remarks on the Palæolithic Implements of the district, etc.," also read before the Geological Society.[1] In this masterly memoir he gave the results of his long and careful examination of, more particularly, Mr. B. Harrison's collection of flint implements from the neighbourhood of Ightham, their distribution and probable age.

[1] Published in the Quart. Journ. Geol. Soc., 1891, vol. xlvii, pp. 126–163.

On the gravelly soils, and in the gravels of certain areas of the Chalk Plateau above Ightham, have been found some deeply stained implements, of either the same kind as those of St. Acheul or those of Chelles in France, "for the most part of oval or ovate forms, but not unfrequently pointed."[1]

M. Mortillet regarded this gravel at Chelles as a high-level river-drift, equal to the oldest of St. Acheul (see also C. H. Read's "Guide to the Antiquities of the Stone Age," British Museum, 1902, p. 9). It may be noticed that two of these ovoidal implements from the Chalk Plateau are figured by Professor Prestwich in his "Controverted Questions, etc.," 1895, pl. xi, figs. 38 and 39, which are referred to by him as being of the St. Acheul type, but either shaped by the same people that made the plateau specimens, by individual progress in the art of shaping tools, or probably by some later valley folk passing over the hills and dropping their weapons and tools (p. 64).[2]

Associated with these implements there occur very abundantly on the Chalk Plateau, as carefully exploited by Mr. B. Harrison, other flints of definite shapes, and deeply coloured, known as 'eoliths' and 'old brownies,' which have been subject to much diversity of opinion among some, especially inexperienced observers. In certain localities, these probably earlier implements occur without being associated with the large ovate forms.

II. *Character of the Eoliths.*

The general features of the eoliths,[3] as we shall continue to designate these ruder and earlier forms, are well marked and distinct.

They are made of flint flakes (sometimes tabular), probably broken off by natural forces, but some are formed of split Eocene pebbles. They rarely show the bulb of percussion. Advantage has been taken by the original worker of natural curves, concave or convex, and these have been modified by well-defined small flakings. In some cases smaller flakes have modified these; in many instances the edges have been further modified by local pressure being used (which we may distinguish as *abrasion*), or in other cases the edge has been rubbed and rounded by *contusion* with other flints in the ordinary course of trituration or wearing away by rolling in a river bed, or in a rough downward passage from higher to lower ground.

The edges of many of the eoliths discovered by Dr. Blackmore in Wiltshire are quite sharp, and cannot have travelled far. I have also one from Hinton Admiral Common, Hants, and another from

[1] Evans: "Ancient Stone Implements," 1897, 2nd ed., p. 608.

[2] I have in my collection one such deeply stained ochreous specimen from Currie Farm, Kent (fig. 6 of pl. xxi, Prestwich, "Primitive Characters, etc.," p. 246). Two others, one ovate (St. Acheul type), and the other (referred to by Prestwich, "Drift Stages, etc.," p. 133) of the sharp-pointed high-level type, with massive butt (tip broken off), are both white and patinated, and are the implements referred to in the text.

[3] They have been termed 'plateauliths' by Mr. Lewis Abbott.

Well Hill, Kent,[1] whose edges are almost or quite free from contusion.

We are now in a better position thus to define the eoliths through Dr. H. P. Blackmore's work at Alderbury during many years. In that deposit at 325 feet O.D., about 3 miles south-east of Salisbury, no palæoliths of accepted type have been discovered, a fact which demonstrates to my mind the later age of some of the more or less ochreous implements of Palæolithic types from the Chalk Plateau of Kent. Thus the Pre-Glacial plateau specimens are divisible into two periods, although Prestwich in his two papers classed them all as palæoliths, and in Professor Rupert Jones' opinion this mixture of early Palæolithic and Eolithic types only shows that man varied his work.

Some Palæolithic implements from the Kent plateau with a porcellaneous lustre have also occurred as surface finds near Bower Lane, Eynesford. These belong to a later epoch, and seem to have been dropped by Palæolithic hunters on the surface and to have been bleached by contact with the clay. The alumina of the clay undoubtedly has this bleaching action, and even softens the flints by extracting the water of crystallization, either as they rested or were slightly embedded in it.[2] This also seems to have been the case of Prestwich's porcellaneous Downton implement quoted by Mr. C. Reid, which occurred at a level to which in age it does not apparently belong.[3] However, the fact remains that from the gravel deposit at Bat's Corner, Kent (the British Association pit excavated by Mr. B. Harrison, 1894, the geological age of which is somewhat uncertain, but probably pre-Glacial), and from the pit at Alderbury worked so assiduously by Dr. H. P. Blackmore (the age of which, from the occurrence of *Pecten asper* and other Gault and Upper Greensand fossils, is that of the Southern Drift), the implements of Palæolithic type are wanting, and the Eoliths wrought and used by man only occur. These are either 'straight sleekers,' 'round sleekers,' or 'hollow scrapers,' certain of them with the point somewhat like a bird's beak, which characteristic form Dr. Blackmore considers especially belongs to implements of the Eolithic epoch.

As this bird-beak point occurs in not a few definite palæoliths (Dr. Blackmore has several in the Museum at Salisbury), and the hollow curve in not a few others (the latter notably in those from the newly discovered Knowle Pit, Savernake), we seem to be arriving at some steps in the evolution of the palæolith.

[1] This specimen, found close to the 500 feet contour, may have been made near the spot where found. Professor Rupert Jones, however, from the point of view of the denudation of the Weald, suggests that implements belonging to the Southern Drift, moving downward along the slopes of the Old Wealden Heights, and enclosed in mud or clay, might travel a considerable distance without being subject to contusion.

[2] Bullen, "Eolithic Implements": Trans. Victoria Institute, 1901, vol. xxxiii, p. 196.

[3] "Geol. of Country round Ringwood," p. 36. The specimen is preserved in the Prestwich Collection in the Geological Gallery of the British Museum (Natural History), in the tenth drawer, left-hand tier.

III. *Researches of Messrs. Blackmore, E. Westlake, and Clement Reid.*

Mr. E. Westlake, F.G.S., is now in the rank of workers on the Eolithic question, and both he and Dr. Blackmore have kindly placed their records from the Plateau terraces (or 'plains') of the Ringwood area at my service in writing this paper. With two such trained and enthusiastic workers on the spot our knowledge ought to advance rapidly.

From 1898, when Dr. Blackmore found an eolith in gravel on the ridge at Woodfalls, near Redlynch, to the present year,[1] a sufficient number of eoliths have been found by both the two above-named workers to constitute the Plateau gravels of the Ringwood district effective witnesses for the existence of man at a less advanced stage of progress as to the manufacture of stone implements—lower, i.e., than in the next or Palæolithic stages of human culture. For these Plateau gravels are the highest in the New Forest district.

Mr. Westlake states:[2] "On November 4th, 1902, I found several examples of eoliths in the east pit on Black Bush Plain, at a height of about 410 feet O.D., or 310 feet above the Avon at Breamore. This gravel caps the highest ground between Fordingbridge and Southampton; and, beyond having a slight slope towards the Solent, has no obvious relation with any of the surrounding valleys. The flatness of the plain and the much rolled and battered character of the gravel, I think, point more to the marine origin suggested by Mr. Codrington (1870) than to the river origin suggested by Mr. Reid (1902). . . . . There can be no question as to the position and antiquity of the gravel."

Mr. Clement Reid has seemingly good reason for his reference to river action, at least in contributing materials for the gravels, in the fact that Jurassic rocks (silicified Purbeck Limestone) occur in the Plateau gravels at 386 feet O.D. near Picket Corner.[3]

As the present paper, however, is rather simple in its scope, the intention being to put on record the occurrence of Eoliths among the Plateau gravels, we leave the existence or not of a Solent river to the evidences for which, *pro* and *con.*, Mr. Reid refers[4] in a useful footnote. He is to be congratulated on breaking free from the usual prejudice and tradition about man's geological age, and on accepting and incorporating, in a memoir issued by the Geological Survey, the long-despised and suspected Eolith.

But in one small particular the "Diagram of the Terraces of the Avon" (fig. 4, p. 34, op. cit.) needs reorganizing, for the researches and 'finds' of Dr. H. P. Blackmore (1898–1902), of Mr. E. Westlake

[1] The writer had previously found hollow curved scrapers at the summit of Alum Chine and on Hinton Admiral Common in May, 1895, and a derived specimen at Jumper's Heath in November, 1893. These were shown to and approved by the late Sir Joseph Prestwich in 1893 and 1895 respectively.

[2] "Antiquity of Man in Hampshire," last page. King's Fordingbridge Almanac, 1903. An eolith from White Shoot Farm is figured in the text.

[3] C. Reid: "Geol. of Country round Ringwood," p. 30.

[4] Op. cit., p. 32, note.

(1902), and of myself (1895) establish the Eolith in the proud position of occupying the high plateau above the 400 feet contour, or its equivalent further to the south. (See Sheets 314, 329, Geol. Survey, new 1 inch map, printed in colours.)

IV. *Eolithic Localities in the Drainage Area of the Avon.*

The under-mentioned localities are those represented in the collections particularized:—

I. Dr. H. P. Blackmore, F.G.S.[1]

		Height above O.D. feet.
1.	Tinney Copse ... ... (This is the White Shoot Pit of Westlake, *infra*.)	375
2.	Deadman Hill Pit, locally known as Alderton	360
3.	Hale's Purlieu	365
4.	Hatchett's Green	345

II. Mr. E. Westlake, F.G.S.[2]

		Approximate height above O.D. feet.		Avon. feet.
	1. Piper's Weight,[3] about one mile north of the last pit (locally 'Long Cross' Pit) on Black Bush Plain	421	...	321
Plains.	2. Black Bush Plain	400	...	300
	3. Turf Hill Pit, south of the Downton Road, about one mile north-west of the Telegraph (= old Semaphore) ...	380	...	280
	4. White Shoot Pit, one mile south of Redlynch	375	...	265
	5. Godshill Ridge Pit, marked on the 6 in. map as Gravel Pit Hill	325	...	235
	6. The eastern pit on Frogham Hill, locally known as Abbot's Well Pit...	260	...	180
	7. Bournemouth: Alum Chine, fallen gravel from top of cliff	120	...	—
Palæolithic.[4]				
Early Palæolithic.				
	Hyde Common Pit	230	...	150
	Sandy Balls Pit...	240	...	150
Middle Palæolithic.				
	Woodgreen Pit	200	...	100

It is noteworthy that all the Eolithic localities examined, both by Dr. Blackmore and Mr. Westlake, occur at a higher level than the second terrace, 300 feet O.D. (the Eolithic), in Mr. Clement Reid's diagram of the Terraces of the Avon,[5] and that the other localities at Alum Chine and Hinton Admiral Common are on the high plateau further south, though at a less elevation O.D. because of the southward slope of the plains.

[1] Blackmore, in letter.
[2] Westlake, in letter.
[3] This is the highest point in the New Forest.
[4] These lower terraces seem to correspond to those so successfully worked by Mr. S. Hazzledine Warren, F.G.S., in the Isle of Wight (Geol. Mag., Sept. 1900, pp. 406–410). They are inserted here merely to contrast the well-defined terraces yielding accepted Palæolithic forms and the higher Eolithic terraces.
[5] Geol. of Country round Ringwood, p. 34.

V. *Criticism of Mr. Clement Reid's statement about the Dewlish Eoliths.*

In concluding this short notice I regretfully animadvert on Mr. Reid's statement[1] that the flints associated with *E. meridionalis* at Dewlish are so battered that their artificial origin is open to much doubt. The only specimen for which this statement could possibly stand is the one numbered 15*f* (Bullen, "Eolithic Implements," pl. iii, fig. 2). The others, Nos. 28, 18, 32, 31*f* (Dr. Blackmore's collection), have much less 'batter' than usual upon their well-defined edges, which circumstance, to those accustomed to discriminate between natural and artificial flaking and chipping, is of most persuasive force. The above-mentioned stone tools are before me as I write. Their colour, originally deeply ochreous, has been lightened very considerably by bleaching in the sandy matrix in which they had so long lain.

VI. *Use of Hollow 'Scrapers.'*

A passage in Sir J. W. Dawson's "Modern Science in Bible Lands," p. 300, deserves quotation in its entirety, as it may throw light on some, if not the majority, of the hollow 'scrapers' so characteristic of Eolithic workmanship, especially when we consider the prime necessity to man of procuring fire in all stages of his civilization :— "When in Egypt in 1844 I saw women in the market at Assiout with baskets of flint flakes on sale. I asked the use of these, and found they were for strike-lights. I asked, 'Why do they not use matches?' The answer was, 'Matches are too dear for the fellaheen. It is much cheaper to have a flint and steel, and a little fibre from the spathe of the doum-palm to light their cigarettes.' I afterwards verified this by examining the tobacco-pouches of some of the people, and exchanged with one of them a new flint for one that he had used so long that its front had been chipped into a semicircular form, like that of one of those hollow scrapers one sees in collections of stone implements, and which are supposed to have been used for polishing shafts of spears, but some of which are possibly worn-out strike-lights of dubious antiquity. It may be observed here that in the most primitive times, before steel could be obtained, the native[2] iron pyrite was used for the same purpose, as evidenced by fragments of it found in very ancient burial-places and caverns of residence."

Iron pyrites, however, is not absolutely necessary for the procuring of fire; the percussion of quartz and flint[3] produces sparks, and probably the percussion of flint or chert with flint[4] would do so, since they are all forms of silica, either crystalline or amorphous.

[1] Ibid., p. 36.

[2] Joly: "Man before Metals," 3rd ed., p. 196.

[3] Jago, Royal Cornwall Gazette, Nov. 29, 1900: Royal Institution of Cornwall Annual Meeting. Mr. A. Pott (of Bath) writes, "I find I can get finer sparks from the quartz and flint than from either with the pyrites."

[4] An illustration of how strike-a-lights of flint, found in the Dordogne Caves, may have been used is given in the *Reliquiæ Aquitanicæ*, Feb. 1870, pt. x, pp. 138, 139, figs. 36, 37.

VII. *Description of Plates.*

PLATE VI.

Fig. 1.—Double-shoulder scraper, work on one face only; sub-ochreous, rather bleached, probably by vegetable action.[1] Deadman Hill, 400 feet O.D. (H.P.B.)

Fig. 2.—Similar implement from Alderbury, split pebble with drusic cavity on reverse, slightly ochreous. Alderbury, 325 feet O.D. (H. P. B.)

Fig. 3.—Bleached, frost-bitten, double-shoulder scraper, showing greatest use on curve of left shoulder; right shoulder produced by removal of a single flake. Sharp edges of each curve removed by local abrasion due to use. Near Tinney Copse, about 375 feet O.D. (H. P. B.)

Fig. 4.—Hollow curve of Upper Greensand chert, having no signs of human use. Hale's Purlieu, about 365 feet O.D. Source: Vale of Wardour. (C. Reid, op. cit., p. 30.)

Fig. 5.—Rough flake from a 'Woolwich and Reading' pebble made into a hollow 'scraper'; edge still acute, resembling others from Alderbury; sub-ochreous; bleached probably by vegetable action. Hinton Admiral Common, 110 feet O.D. May 28th, 1895. (R. A. B.)

Fig. 6.—Bleached hollow 'scraper' just below summit of Alum Chine, much more rolled than Fig. 5. Alum Chine, about 110 feet O.D. May, 1895. (R. A. B.)

PLATE VII.

Fig. 1.—Ochreous, hollow, beaked 'scraper' from Alderbury; edges of curve sub-acute. Alderbury, 325 feet O.D. (H. P. B.)

Fig. 2.—Ochreous, hollow, beaked 'scraper,' sub-acute, blunted by local abrasion through use, or contused by natural causes. Near Tinney Copse, about 375 feet O.D. (H. P. B.)

Fig. 3.—Sub-ochreous, hollow 'scraper,' frost-bitten, sub-acute, with a convexo-concave surface showing work on both faces. Deadman Hill, about 360 feet O.D. (H. P. B.)

Fig. 4.—Massive hollow 'scraper,' bleached by contact with clay or loam. Porcellaneous on worked curve and other parts; the high patina probably caused by the scouring of water containing sand or silt. Near Tinney Copse, about 375 feet O.D. (H. P. B.)

Fig. 5.—Hollow 'scraper' with well-defined symmetric curve, showing primary and secondary chipping and local abrasion from use, the latter modifying the sharp edge produced by the smaller secondary chipping. Deeply ochreous, older than the valley gravels with which it was associated. Jumper's Heath, about 20 feet O.D. (R. A. B.)

MAP, PLATE VIII.

Incidentally one is inclined to discount the value of mineralogical condition, at all events in determining the age of Eolithic implements. Taking the hollow scrapers as an example, though of the same type, these show, even from the same deposit, e.g. Alderbury, great differences as regards stain, hardness, patina, and wear.

In conclusion I would thank Dr. Blackmore and Mr. Westlake for their kind co-operation, and Professor T. Rupert Jones, F.R.S., for helping me both in the manuscript and the proofs.

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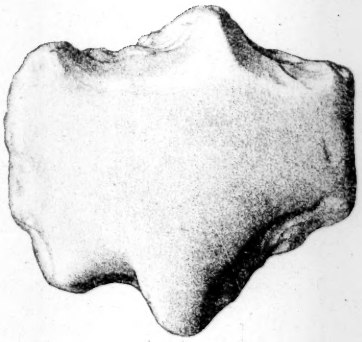
[1] For rationale of this bleaching of flints, see Codrington on the superficial deposits of the South of Hampshire and the Isle of Wight: Quart. Journ. Geol. Soc., 1870, vol. xxvi, p. 528.



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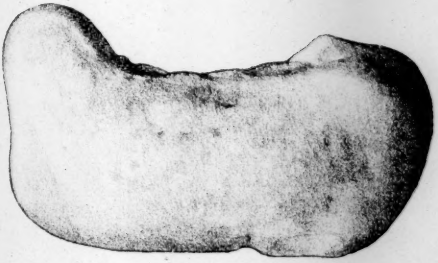

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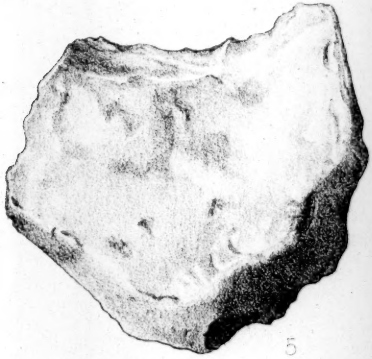

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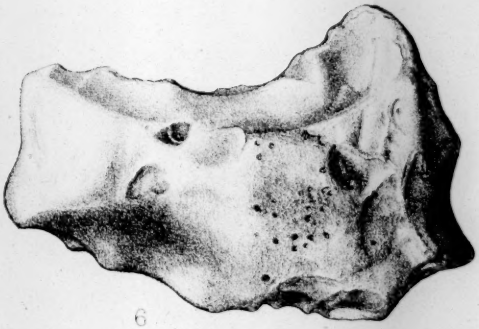

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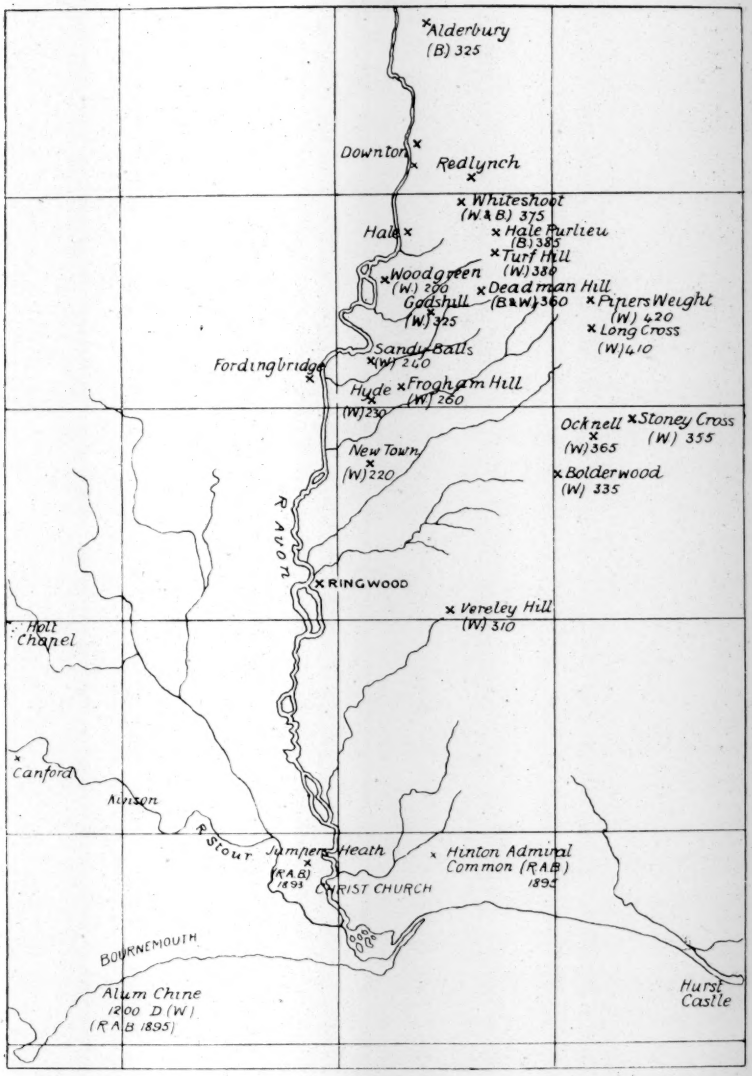
G. M. Woodward del. et lith. West, Newman imp.

Eoliths, *from S. W. Hants.* $\frac{3}{4}$ *nat size.*



K. Ashington Bullen.

Eoliths from the Plateau-Gravels of South-West Hants, near Ringwood.

Map showing the course of the Avon below Downton.

W., Westlake; *B.*, Blackmore; *R.A.B.*, Bullen. The squares are each five miles.

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IV.—On some Remains of a Gigantic Fossil Cirripede from the Tertiary Rocks of New Zealand.

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(PLATES IX AND X.)

In the course of conversation with Professor J. Park, the Director of our School of Mines, I first heard of the occurrence of a gigantic pedunculated Cirripede in certain Tertiary deposits on the east coast of the North Island of this colony. I then wrote to

Mr. T. F. Cheeseman, the Curator of the Auckland Museum, in which some remains were exhibited: in answer to my request, Mr. Cheeseman very generously loaned me these remains, and the following notes are founded on them. I will here express my thanks to this gentleman for the readiness with which he has, in this and other instances, complied with my request for the loan of specimens out of his museum. But these few fragments do not represent all that is known of the animal; for I understand that abundant material, collected by Professor Park during his geological survey, is entombed in boxes in the Colonial Museum at Wellington, and Professor Thomas, of Auckland, also possesses, as he informs me, a fair supply of valves, collected by himself.

I have, however, not been able to examine either of these collections. And although the present contribution is very incomplete, yet I hope that it will stimulate the possessors of better material to supplement or correct my remarks; at any rate, it will serve to direct the attention of European geologists and zoologists to the existence in late geologic times of a Cirripede remarkable chiefly for its gigantic size, far surpassing any member of the group hitherto known to science.

Portions of this fossil were exhibited in 1887 by Sir James Hector at a meeting of the Wellington Philosophical Institute, when he made the following remarks:—[1]

"The large fossil Cirripede collected by James Park will probably be found to belong to the genus *Scalpellum*, and is distinguished provisionally under the name *Sc. Aucklandicum*. In size this fossil Cirripede exceeds greatly any previously known; in *S. magnum* the capitulum being $1\frac{1}{2}$ inches in length, while in the Auckland specimen it is at least 8 inches.

"The fossil occurs in a breccia marking an old shore-line of the upper part of the Waitemata series, similar to the Cape Rodney beds. The associated fossils are corals, brachiopods, and echinoderms. Among the latter are two specimens of *Cidaris* having plates of enormous size."

These fossils were collected on the island of Motutapu, in Auckland harbour. Park[2] states that "the island consists of Tertiary sandstone and clays on a highly denuded surface of slates, sandstones, and schists, of probably Palæozoic age."

According to Sir James Hector, the Waitemata series belong to his 'Cretaceo-Tertiary' system, whereas Captain Hutton regards it as Miocene.[3]

Sir James Hector, as above stated, attributed the fossil to the genus *Scalpellum*, and proposed the name *Sc. Aucklandicum*, without, however, further describing it.

But, I think, a careful comparison of the scutum and carina with the fossil valves described by Darwin indicates a closer resemblance to certain species of *Pollicipes*; nevertheless, I do not think I am

[1] Trans. N.Z. Institute, vol. xx, p. 440.
[2] Geological Reports (N.Z. Government), 1887, p. 225.
[3] Hutton: Trans. N.Z. Institute, vol. xxxii, p. 171.

justified in transferring it to this genus till a greater number of valves have been studied, especially in consideration of the difficulties, pointed out by Darwin, of distinguishing the two genera from the valves only; and it must be borne in mind that the criteria put forward by him are not applicable to the living forms, for he expressly limited them to fossil representatives.

The only character referred to by Sir J. Hector is the great size of the fossil; and certainly this is, as it happens, a sufficient diagnosis of the species. The largest capitulum known amongst living species of *Scalpellum* is that of *Sc. Darwinii*, Hoek, which attains a length of 46 mm. (nearly 2 inches); and only a few other species approach this size, viz., *Sc. eximium*, Hoek, 43 mm.; *Sc. gigas*, Hoek, 40 mm.; and an undescribed species in my possession from the coast of this island is of the same length as the last. Amongst fossil forms, the largest capitulum recorded by Darwin is $1\frac{1}{2}$ inches (about 37 mm.) in length, and only two entire capitula reached this size, viz., *Sc. magnum* and *Sc. maximum*.

Turning to *Pollicipes*, all the known species are of small size; existing forms are less than 1 inch (25 mm.), and the only entire capitulum described by Darwin was $\frac{1}{2}$ inch (say 13 mm.) in length.

It will be seen, then, that the capitulum of the species of which certain valves are described in the present article was of extraordinary size; it must have attained the enormous length of nearly a foot (300 mm.), and possibly more; for the tergum would, by analogy with other elongated species, project considerably beyond the scutum, while the inferior valves would still further add to the length.

The material at my disposal includes four recognizably identifiable valves, with some fragments insufficiently complete to describe, though one amongst the latter is, I believe, a portion of one of the lower series of the capitulum, probably the 'carinal latus.'

The four recognizable valves are—

(*a*) The *carina*.
(*b*) The *scutum* of the left side.
(*c*) The *rostrum* (?).
(*d*) One of the lower whorl (? the 'upper latus').

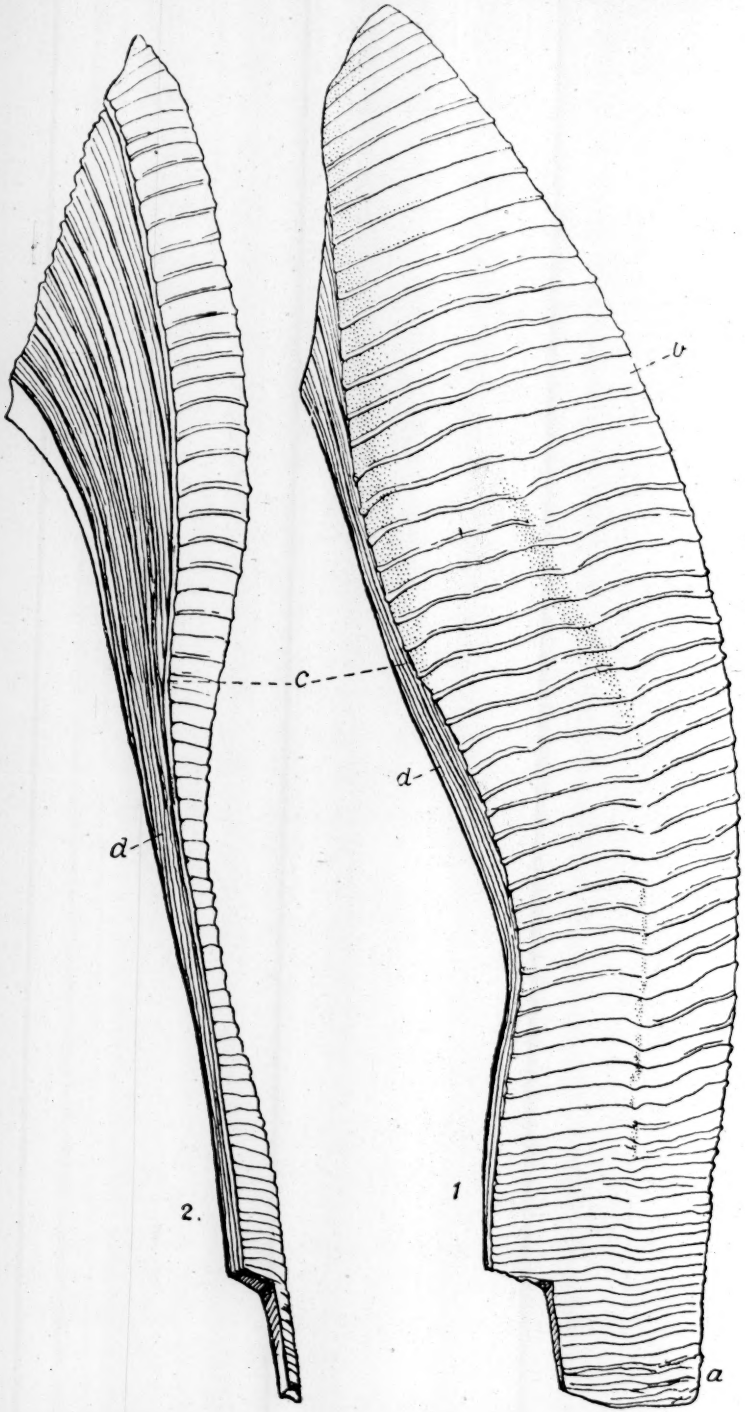
But there is no evidence to show that these plates belong to one and the same individual.

(*a*) *The Carina*. (Pl. X, Figs. 3–7.)

This valve is represented by one almost complete specimen and another less complete, and some broken fragments.

The more complete valve consists of a median, transversely ridged roof-plate, a 'tectum' (of Darwin), with a pair of inflexed 'parietes' forming a flange on either side.

The tectum is long, narrow, nearly flat at the basal extremity, but much arched from side to side distally. It is gently curved in the longitudinal direction, but there is no evidence to show that it was angularly bent upon itself. The basal extremity is uninjured; the inner surface slopes gradually to meet the outer surface, so that


b
c
d
d
2.
1
a

a rough but definite edge is here formed. The breadth of the tectum remains nearly uniform over the lower half, but widens very slightly near the middle; it then diminishes very gradually towards the distal portion; although the apex is absent, it was probably about half the breadth of the base. The lines of growth are practically transverse, and, as frequently is the case, those near the middle are more widely spaced than at the proximal extremity, where they are rather oblique.

The parietes are nearly complete, but are partly broken away near the distal extremity. Seen laterally, each parietes is practically a triangle, with a very long curved base, attached, of course, to the margin of the tectum. The lower or proximal side of the triangle is longer than the distal, and is slightly excavate, i.e. it is not a straight line. The distal side, as far as can be judged, is a straight line; what is left of it appears to be uninjured. The lines of growth on each parietes are very close set; starting from the basal extremity they at first run nearly straight, but slightly obliquely, upwards; then, where the flange widens out, they curve outwards and bend abruptly backwards, terminating along the distal side of the triangle. There is thus left a small smooth 'bay,' triangular in form, on the proximal side of the apex.

There is no ridge, but the surface suddenly drops along the line of junction of tectum and parietes; the angle formed by each of the latter with the former is about 135°.

The upper end of the valve is broken, but if the tectum be produced to meet the production of the distal side of the triangular parietes, the point of union will add about 25 mm. to the total length of the carina.

The inner surface of the valve is, in its upper half, marked by a series of fine transverse ridges and furrows; at the actual point of bending there is a narrow and well-defined ridge, while below, the surface is smooth.

The following measurements were made:—

	mm.
Length of fragment...	133
Probable total length ... ... about	160
Greatest breadth of tectum...	18
Breadth at base	15
Breadth at fractured end	10
Thickness	2
Parietes—greatest breadth	25

(*b*) *The Scutum.* (Pl. IX, Figs. 1–2.)

This valve is $7\frac{1}{2}$ inches in length, and only $1\frac{1}{2}$ in breadth; it is thus remarkably narrow in proportion to its length. It will be convenient to distinguish a 'main plate' from a 'flange' which exists on one side, and is scarcely seen when the valve is looked at squarely from above; this 'flange' is the greatly inflexed latero-tergal region of the valve, which is set on to the 'plate' at an angle of about 115°. The 'main plate' is almost complete. There appears to have been a small apical region broken or worn away; but apart

from this, and a small rectangular portion broken off the base which does not affect the shape or measurements, the valve is entire.

The basal margin is straight; the lateral and occludent margins form right angles with it, and are therefore parallel for the lower third of their course. The occludent margin, as a whole, is a continuous convex curve; while the other margin of the main plate is doubly curved, so as to form an S-shaped line, which is at first parallel with the occludent margin, then bends away from it, and finally curves gently towards it, so that a blunt apex is formed.

The surface of the plate is nearly flat from side to side in its proximal region, but is distinctly convex as the distal extremity is approached. Moreover, when viewed from the side, the plate exhibits a gentle S-shaped bend, the middle of it being concave outwards, the upper and lower ends convex.

The lines of growth are transverse, nearly straight, and are sufficiently prominent over the greater part to form slight ridges, but these become evanescent towards either end, and at the same time the growth-lines become closer together, especially as the basal margin is approached, where they are very crowded.

The 'flange' or tergo-lateral region of the scutum is very much inflexed, forming, as I have stated, an angle of about 115° with the main plate; it is somewhat thinner than the latter, and is triangular in form; the apex of the triangle, the tergo-lateral angle, i.e. its widest part, where it is 20 mm. across, is at the same level as the widest part of the main plate; the proximal side (lateral margin) passes down and soon becomes nearly parallel to the side of the plate, whilst its distal side (tergal margin) is shorter and passes to the apex of the main plate.

The flange differs in appearance from the plate itself, owing to the direction and character of the lines of growth; these are very fine and close together, their general course is longitudinal, but gradually curving outwards to reach the tergal margin, where their ends constitute a slight ridge; this margin is, I believe, the true uninjured edge. In thus curving outwards a small smooth bay is left on the proximal side of the tergo-lateral angle.

I have been unable to examine the inner surface of the valve, as it is closely attached to the matrix, but the concavity extends up to the apex.

The following measurements were taken :—

	mm.
Total length of scutum	187
Greatest breadth of main plate	38
Basal breadth	30
Thickness at base	2·25
Thickness at apex	1
Greatest breadth of flange	20

(*c*) *The Rostrum* (?). (Pl. X, Figs. 8–9.)

This valve is undoubtedly one of the median plates of the inferior series; it may be either the rostrum or sub-carina. It is much smaller than the preceding valves, is quite symmetrical and hastate

in form; the longer axis is median, and the shorter axis much nearer the broader end. One end of the plate is sharply pointed, while the opposite angle is much more obtuse.

The valve is arched in the longitudinal direction, and is markedly convex from side to side; at the broader end a distinct but low keel occupies the median line.

The surface is marked by closely set lines of growth angulated in the middle line, the angle being directed towards the broader end.

	mm.
Length of rostrum	45
Greatest breadth	13

(*d*) *One of the Lateral Valves.* (Pl. X, Figs. 10–11.)

One of the valves, which at a first glance somewhat resembles the apex of a scutum, is doubtless one of the series of lateral plates, very probably the 'upper latus.' Unfortunately it is imperfect, but so much of it remains that it is possible to get an idea of the shape, though not, perhaps, of the size, of the perfect valve. Like the scutum, it consists of a 'chief plate' and a 'flange,' which, however, lie nearly in the same plane.

The 'chief plate' is long, narrow, and symmetrical, about a median line; one end is broken across, the other is a blunt point. The two lateral margins are symmetrically curved, nearly parallel at the fractured extremity, but gradually approximate in the opposite direction, so as to form feebly convex margins. The plate is marked by nearly transverse growth-lines, which in the proximal moiety are slightly distorted by a linear depression cutting across them nearer one margin than the other. This depression traverses about one-half the length of the plate, at first parallel to the margin, but later bending away from it towards the middle line.

On one side of the main plate is a thinner, narrow flange, triangular in general form; it is in reality merely the slightly inflexed margin of the valve, and, as in other cases, the lines of growth take a different direction from those on the main plate, passing obliquely upwards to cut the distal side of the triangle, which is uninjured, and slightly thickened.

	mm.
Length of fragment	70
Breadth of main plate	22
Greatest breadth over all	30
Thickness	1·5

Remarks.

Having given an account of these valves, I will proceed to consider those characters which may enable us to place the fossil in its proper genus. The question naturally arises, is the fossil a member of the genus *Scalpellum*, or is it *Pollicipes*?

In his classic monograph on the fossil Cirripedes, Darwin[1] points out the difficulties of deciding the matter when only a few valves are available; and in his work on the living forms,[2] he also

[1] "A Monograph on the Fossil Lepadidæ": Palæont. Soc., 1851.
[2] "A Monograph on the sub-class Cirripedia (Lepadidæ)": Ray Soc., 1851.

indicates the difficulty of drawing any hard and fast line between the two genera. In fact, one of our New Zealand species, *Scalpellum villosum*, is the very stumbling-block that he discusses. Nevertheless, Darwin, from his great experience in identifying these Cirripedes, indicates certain characters on which he relies, at any rate for fossil forms, in discriminating between the two genera.

In speaking of the *carina*, Darwin thus characterizes it for fossil species of *Scalpellum* (p. 17): it is "narrow, widening but little from the apex downwards, slightly or considerably curved inwards"; and adds further down the same page that "the chief character by which the valve can be recognised as belonging to *Scalpellum* is the distinct separation, by an angle often surmounted by a ridge, of the tectum from the parietes, which are either steeply inclined or rectangularly inflected; the lines of growth on the parietes are oblique."

On the other hand, in *Pollicipes* the carina is described (p. 49) as being "either bowed inwards or is straight; it widens from apex downwards more rapidly than in *Scalpellum*; generally a considerable upper portion projects freely, and this portion is always much less concave than the lower part." Further on he says, "the parietes are generally more or less inflected, but they are not separated by any defined ridge or angle from the tectum. Lines of growth on the parietes are transverse or only slightly oblique."

From these two quotations it would appear pretty certain that the carina described above would be attributable to the genus *Scalpellum*. But in examining the plates illustrating this genus we find in none of the species a carina that resembles that under discussion.

The present fossil has not only a much narrower tectum, but the difference in width at the two extremities is very much less than in any figured. The base, and therefore the lines of growth, are in the latter angulated, instead of being transverse as in our fossil. Again, the parietes are in most of the figures scarcely, if at all, visible in a dorsal view of the valve, since they are much more steeply inclined to the tectum than in the present instance. Further, the parietes in Darwin's species of *Scalpellum* is either a continuously curved plate of nearly equal width throughout, or its edge forms a chord to the arc of a circle described by the tectum.[1]

In our fossil we do not know with absolute certainty the true curve nor the true length of the carina, nor the position of the umbo; nevertheless, the appearance presented by the oblique margin of the distal moiety of the parietes leaves little doubt but that it is the natural, uninjured margin. If this be the case, and if we suppose this edge to be produced to meet a continuation of the tectum, we shall obtain the true form and size of the whole valve, which is not greatly curved nor much longer than the portion preserved, while there is no reason to doubt that the umbo is terminal.

Now it is a distinctly remarkable fact that the only carina figured by Darwin that does bear resemblance in the points above referred

[1] There is one exception, *Sc. magnum*, in which, however, the umbo is not terminal as it is in the rest, and as it is, in all probability, in our fossil.

to is attributed to the genus *Pollicipes*, viz. *P. reflexus* (see pl. iii, figs. 8*a–c*). In this species, as in one or two others, the lines of growth, and therefore the base itself, are transverse and straight; the parietes are seen from above, and, though not precisely like those of the present fossil, yet bear a closer resemblance to it, in possessing a slight angle on its margin, than do those of any of the species of *Scalpellum*; while the inclination of the parietes to the tectum, as represented in the transverse section, is also similar, as is the general direction of the lines of growth, though the angulation of these, which occurs in our fossil, does not appear to exist. It is, moreover, the only Tertiary *Pollicipes* described in the monograph, having been found in the 'upper marine Eocene' at Colville Bay, Isle of Wight.

The *scutum*: in its greatly elongated and much narrowed form this valve is quite unlike that of any of the fossil species either of *Scalpellum* or of *Pollicipes* figured by Darwin; but among living species *Sc. album*, Hoek,[1] has a very similar valve, so far as its general proportions are concerned. But what seems to distinguish our valve as much as any other feature is the very marked inflexions of the tergo-lateral region; in most of those figured by Darwin this 'flange' appears to lie very nearly in the same plane as the 'chief plate' itself; although in the description of some of the species, e.g. *Sc. arcuatum* and *P. Angelini*, he states that the "tergo-lateral portion is inflexed."

Darwin, in his diagnosis (p. 17) of *Scalpellum*, says, "scuta very slightly convex, four-sided, tergal and lateral margins being divided by a slight angle"; whereas *Pollicipes* (p. 48) possesses scuta which are "generally three-sided, but sometimes, either from the baso-lateral or rostral angle being truncated, there is an additional side. The tergo-lateral margin is either straight or, generally, more or less convex, but it is never divided into two distinct margins."

Now, if our scutum be examined merely from the outside, the tergo-lateral margin is scarcely angulated, and the general outline (except for its great elongation) resembles the scutum of *P. Angelini* or *P. acuminatus* much more nearly than it does any of the figures of *Scalpellum*. If, however, it be viewed from the side there is a more distinct angle, but even this is not so pronounced as in *Scalpellum*, in which the part that I have termed 'flange' appears to be less differentiated than in our species or in the genus *Pollicipes*. On the whole our valve seems to agree rather with that of *P. Angelini* than with any other fossil Cirripede. In his description of the scutum of this species Darwin writes (p. 57): "The tergo-lateral portion of the valve, formed by the upturned lines of growth, is not much developed; the tergo-lateral margin, as seen externally, is obscurely divided into two lines, of which the upper or tergal portion has its edge reflexed."

In reference to the other two valves described, very few words are necessary. The one which I suggest is 'rostrum or sub-carina' is, like our other valves, much narrower than in other species, either

[1] Hoek: "The Cirripedia (Systematic Part)," *Challenger* Reports, 1883, viii.

of *Scalpellum* or of *Pollicipes*. Of the former, only the rostrum of one fossil species is known, though, as Darwin pointed out, others probably possessed it. Amongst living species some have and others have not a rostrum. In *Pollicipes*, he says, the rostrum "resembles the carina, but is shorter and proportionately broader." Of the sub-carina we have practically no information.

The form of the latera is very varied in both genera, but only in a few cases are the lines of growth straight, as in *P. glaber* (pl. iii, figs. 10*f*, *k*), where it is nearly a right-angled triangle. In any case, it seems unlikely that these valves will have a diagnostic value.

It occurred to me that some relation in length might exist between carina and scutum, and that a comparison of this relation in *Scalpellum* on the one hand and *Pollicipes* on the other might aid me in determining the genus of the fossil.

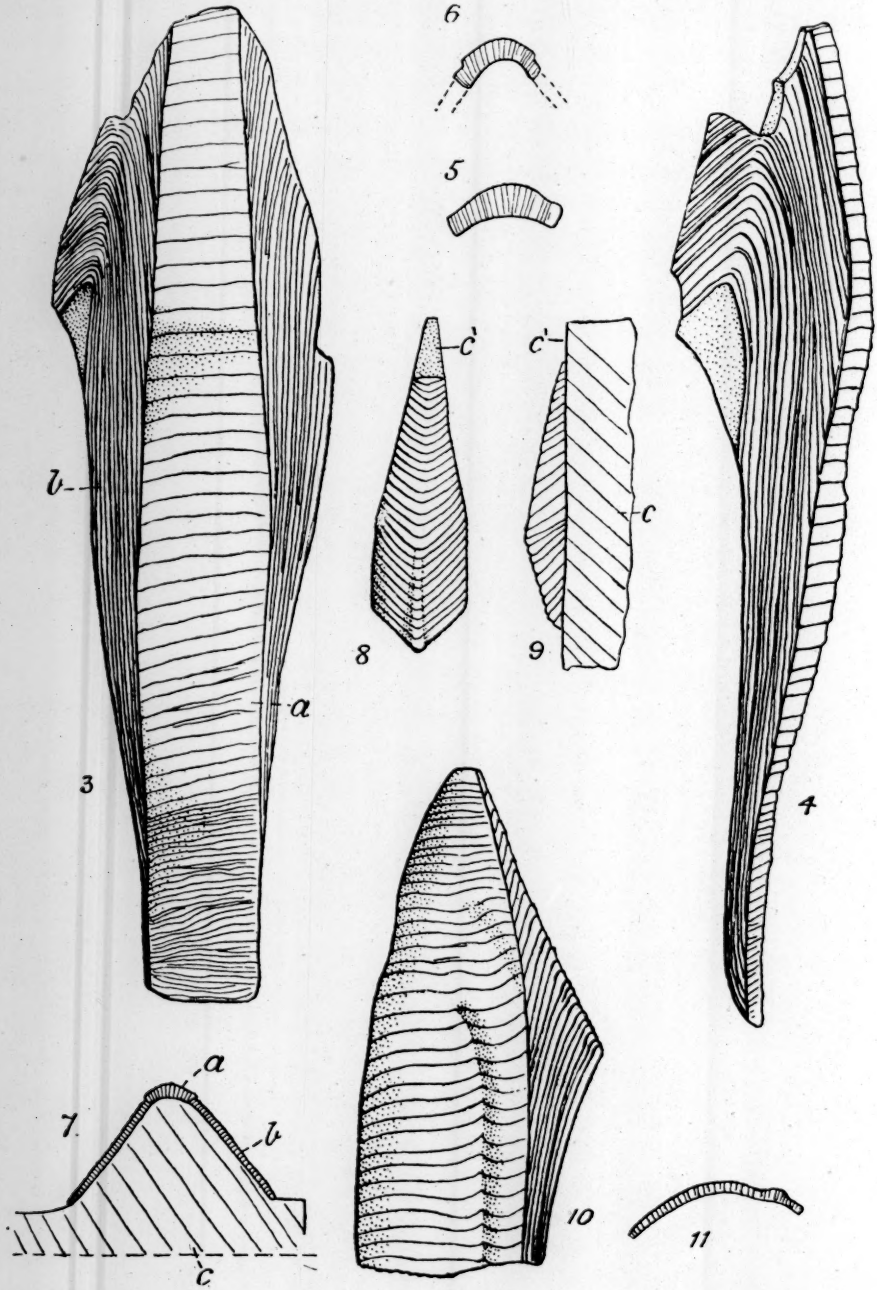
But an examination of the material contained in Darwin's monograph of the fossil forms soon showed the unreliability of this method of investigation as applied to them, for it is extremely rare to find a complete capitulum or a set of valves *in sitû* which can be, without any doubt, attributed to an individual. Indeed, only two species of *Scalpellum* and one of *Pollicipes* in this condition are recorded by him.

Further, even in the case of figures of the entire capitulum of living species it is not always possible to measure with absolute accuracy the various valves. Nevertheless, from the figures given below, derived from measurements of Darwin's and Hoek's representations of the species, a certain proportion—not by any means a constant proportion, however—may be deduced in regard to the relative lengths of carina to scutum.

It will be seen that in *Scalpellum* the carina is always longer, usually much longer, than the scutum; whereas in the case of *Pollicipes* these two plates are much more nearly, or even actually, of the same size.

	[Length of capitulum, 100.]	
Scalpellum.	Length of carina.	Length of scutum.
vulgare	83	58
rostratum	83	58
ornatum	77	55
Peronii	77	55
rutilum	87·5	62·5
Stroemii	80	50
Japonicum	89	64
recurvirostris	89	53
Darwinii	78	58·7
regium	90·9	60·6
eximium	82·5	75
gigas	85	57·5
tritonis	93·4	54·8
Pollicipes.		
spinosus	71·2	71·2
cornucopia	70	70
polymerus	75	62·5

In attempting to apply this method of comparison to the valves under discussion, we are in this dilemma, that we do not know—in



A giant Cirripede (*Pollicipes*? *Aucklandicus*) from Tertiary Beds, Auckland, New Zealand.

Figs. 3–7, the carina ; Figs. 8–9, the rostrum ; Figs. 10–11, the latus (?). All figures nat. size.

fact, we have strong reason to doubt—whether these valves belong to one and the same individual. But it is, at any rate, noteworthy that the only scutum and the only approximately entire carina in this small collection should agree so nearly with the conclusions derived from a study of *Pollicipes*, for the scutum measures about 190 mm. and the carina about 160 mm., allowing for the probable damage at the end.

In other words, we are more likely to find in the entire capitulum of this fossil that these two valves are nearly equal in length, than that the carina greatly exceeds the scutum in length, as is the case in the genus *Scalpellum*.

So far, then, as this rough calculation goes, it bears out the view expressed above that the fossil belongs to the genus *Pollicipes* as defined by Darwin in dealing with the fossil pedunculate Cirripedes. For a determination of this point, however, we must await the researches of those who have a larger supply of material at their command.

EXPLANATION OF PLATES IX AND X.

Fig. 1.—The left scutum of *Pollicipes* (?) *Aucklandicus*, viewed from the outer side, showing the form of the 'chief plate.'

Fig. 2.—The scutum, seen edgewise, to show the outline of the 'flange,' or much inflexed tergo-lateral margin, as well as the general curvature of the plate. *a*, basal margin; *b*, occludent margin; *c*, tergo-lateral margin; *d*, 'flange.'

Figs. 3–7.—The carina. Fig. 3, dorsal view. Fig. 4, side view. Fig. 5, the basal margin, seen end on, to show form of tectum. Fig. 6, the fractured edge, to show the curvature near the distal region. Fig. 7, transverse section of another specimen of smaller size, at about the level of the middle of the valve.

Fig. 8.—The rostrum, external view; a small portion of the apical region is broken away, but the impression (*c'*) on the rocky matrix shows the length of the missing part.

Fig. 9.—The rostrum, side view.

Fig. 10.—The doubtful 'latus,' broken across its lower end, external view.

Fig. 11.—The same, viewed from the broken end.

V.—On the Origin of the Mosasaurs.

By Baron Francis Nopcsa, Jun.

CONCERNING the origin of the Mosasaurs three altogether different views exist: G. Baur regarded the Mosasaurs as highly specialized aquatic Varanoids; Boulenger is inclined to trace their origin back to the Neocomian Dolichosaurs; and Osborn, in a recent paper, doubts that Varanids and Mosasaurs sprang from a common stem, and regards the latter as "a very ancient offshoot of the Lacertilia." Some Lacertilia found in recent years in the Lower Cretaceous of Dalmatia, and not yet fully compared with the Mosasaurs, will, I believe, throw fresh light on this subject. Among the fossil Lacertilia found in Dalmatia two types can be distinguished, namely, Dolichosaurs and Aigialosaurs, the former including the genera *Dolichosaurus* Owen, *Pontosaurus* Gorjanovic-Kramberger (=*Hydrosaurus lesinensis*, Kornh.), *Acteosaurus* Meyer, and *Adriosaurus* Seeley; the latter, *Aigialosaurus* G.-Kramberger,

Carsosaurus Kornh., *Opetiosaurus* Kornh., and perhaps also *Mesoleptos* Cornaglia.[1]

The following chief differences are observable between these two types:—

Dolichosaurs.	Aigialosaurs.
Skull relatively small. Quadrate bone probably slender. Mandible slender. Teeth thecodont?	Skull relatively large. Quadrate round as in Mosasaurs. Mandible strong. Teeth in sockets.
Vertebræ: neck remarkably long, consisting of 13 vertebræ. 26 dorsal vertebræ.	Neck short, composed of only 7 vertebræ. 21 dorsal vertebræ.
Ribs: dorsal ribs equally long and relatively short. No ventral ribs.	The long dorsal ribs vary in length. Ventral ribs well developed.
Limbs: anterior limbs much reduced in size. Hind-limbs twice as long as fore-limbs. Metatarsal v not showing Varanid modification.	Anterior limbs comparatively long. Only somewhat longer. Metatarsal v showing distinctly Varanid modification.

According to the description here given the *Dolichosaurus*, as pointed out by Osborn, cannot be the ancestor of the Mosasaurs, whereas the same cannot be said of the Aigialosaurs. The most remarkable points of resemblance and difference between the Aigialosaurs and Mosasaurs are as follows:—

Aigialosaurs.	Mosasaurs.
Skull: *upper surface* in both cases perfectly the same and strongly resembling the Varanids. *Quadrate bone* in both types broad and flattened, thus differing from the same bone in the living Varanidæ. *Articulation between the front and hind parts of the mandible* present in both types and absent in the Varanidæ.	
Vertebræ: 7 cervical vertebræ, no sign of primitive structure; 21 dorsal vertebræ, like those of the Varanidæ.	Seven cervical vertebræ, showing very primitive structure (due to pelagic life?); dorsal vertebræ varying from 22 (*Tylosaurus*) to 36 (*Clidastes*).
Ribs: the sternal ribs are equally developed in both, and their position indicates in both cases the same kind of sternum, with this difference:—	
Sternum broad and large; 6 sternal ribs touching the sternum. Shoulder-girdle well developed.	Sternum comparatively small; 10 true sternal ribs present. Shoulder-girdle somewhat reduced.
Fore-limbs intermediate between the Mosasaurid and Varanid type.	Fore-limbs changed to paddles.
Pelvic girdle well developed. Two sacral vertebræ present.	Pelvic girdle reduced. Only one sacral vertebra.
Hind-limbs like front-limbs, both extremities bearing sharp claws.	Hind-limbs paddles; hyperphalangy, and no claws present.

Dermal covering consisting in both cases of rhomboidal scutes bearing a slight median elevation.

It is thus evident that the *Aigialosaurs show great affinity to the*

[1] This classification does not correspond with the one given by Gorjanovic-Kramberger.

Mosasaurs, differing from the latter only in not being as thoroughly adapted for pelagic life. On the other hand, the *Aigialosaurs show*, as remarked by Kornhuber, *a strong resemblance to the living Varanids, differing from these only in those points by which they approach the Mosasaurs.*[1]

The question arises now, do the Aigialosaurs represent the most primitive Mosasaurs or a family in the suborder of the Lacertilia? Taking the Mosasaurs, on account of the development of their paddles, as a distinct suborder of the Squamata, the Aigialosauridæ would prove to be a distinct family among the Lacertilia, approaching greatly the Jurassic type from which the Cretaceous Mosasaurs and the recent Varanidæ are the offspring. This type, being terrestrial, would of course bear greater resemblance to the modern Varanids than to the pelagic Mosasaurs.

A paper dealing more fully with this highly interesting subject is to appear in the Geolog. und Palaeontolog. Beiträge in Vienna.

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[1] It cannot be certainly known whether the pterygoids of the Aigialosaurs bore teeth, but I am inclined to believe they did, since in *Opetiosaurus* the crown of a tooth lying near the hyoid bone (=columella of Kornhuber) seems to differ in size both from the mandibular and (presumably also) maxillary teeth of this animal.

VI.—The Geological Chronometer.

By G. W. Bulman, Esq.

THE pleasant relations normally existing among geologists, biologists, and physicists have of late become a trifle strained on the question of the age of the earth. Biologists, having failed to induce either geologists or physicists to draw sufficiently large cheques on the bank of time, have taken to signing the same themselves, adding the ciphers *ad lib.* Professor Poulton has ably championed the rights of the biologists to do so,[1] and in the course of his argument he contends that there is evidence in the sedimentary strata to show that their rate of formation was *not* greater than that at which deposits are now being accumulated.

So far as I am aware, Professor Poulton's contention has not been either controverted or supported by any geologist. Hence it seems to be a suitable subject for discussion in the Geological Magazine.

In the first place, then, what would be the nature of the evidence we might *a priori* expect to find to show that one set of beds was accumulated in a shorter time than another of equal thickness? Would there, in fact, be any difference such as would enable us positively to decide the question?

Secondly, we may examine and compare rocks which we know, or have reason to suppose, have been formed at different rates. Now, according to Sir A. Geikie, if the rocks of the stratified systems were laid down at the greatest rate suggested by the facts of denudation, 73,000,000 years would be required; if at the least, 680,000,000. In other words, the greatest rate of formation is more than nine times the least. We ought, then, to be able to put the question to the test of actual observation. Do the deposits formed at the greater rate differ in any essential characters from those formed at the lesser? If we can establish any difference by observing recent deposits, then we can apply the criterion to the strata of past ages. But, so far as I am aware, no geologist has pointed out any specific characters by which a quickly formed deposit can be certainly distinguished from a slowly formed one. This may be, of course, that they have not specially looked for such characters. It seems more probable, however, that there are no reliable criteria.

"The geological agency to which attention is chiefly directed by those who desire to hurry up the phenomena of rock formation," Professor Poulton tells us, "is that of tides." And to prove that tides were not sufficiently high in time past to do so, two things are relied on.

First, that the rocks indicate deposition under *tranquil* conditions, and secondly, that "extremely delicate organisms" are found in them.

"There are, then, among the older Palæozoic rocks a set of deposits than which we can imagine none better calculated to test the force

[1] Presidential Address to the Biological Section (D), Brit. Assoc., Liverpool, 1896.

of the tides; and we find that they supply evidence for exceptional tranquility of conditions over a long period of time."

But, we ask, would the existence of higher tides necessarily destroy this appearance of tranquility? There is, so far as I am able to grasp the facts of the case, no grounds for supposing that higher tides would prevent tranquility of deposition. But we can put the matter to the proof. We have deposits which have been laid down in lakes and inland seas where there are no tides. Do these show the marks of tranquil deposition—whatever these are—to a greater degree than those of the open ocean? Would any geologist be able to distinguish the deposits of the Mediterranean as having been laid down under more tranquil conditions than those of the Atlantic?

As regards the extremely delicate organisms which, Professor Poulton remarks, are found in the Silurian, it is difficult to realize how a higher tide would affect them. And it is not quite clear whether it is the fact of these delicate organisms having lived or their having been preserved which is supposed to show that the tides were not appreciably higher in Silurian times. Professor Poulton's exact words are :—

"The remains of extremely delicate organisms are found in immense numbers, and over a very large area. The recent discovery, in the Silurian system of America, of trilobites, with their long delicate antennæ perfectly preserved, proves that in one locality (Rome, New York State) the tranquility of deposition was quite as profound as in any locality yet discovered on this side of the Atlantic."

If the higher the tide the less delicate the organism capable of living in the water, then the organisms of the Mediterranean ought to be more delicate than those of the Atlantic. Here, then, we can appeal to facts. As the question is outside the scope of my knowledge I must leave it in the form of a query. But, so far as my geological knowledge carries me, the fossils of lake and inland sea deposits are not of more delicate organization than those found in the strata of the open ocean.

And if the finding of a few of the "long delicate antennæ" of trilobites in America proves the profoundness of the tranquility, what does their universal absence in this country show? Again, there arises the question of the relative delicacy of the organisms of the Silurian. Have we the right to say they are as delicate as some of the organisms of our present seas? Can we, for example, really say from what we know of their remains that the graptolites were not able to stand more tossing about—assuming for a moment that higher tides would make it more tempestuous — than the *Sertularia* of our present seas? The chitinous rod of the graptolite *may* have been very tough and strong. We have no means of measuring its strength. It must be left an open question whether or not it was fitted to live in a more stormy ocean than the present.

Again, Professor Poulton says :—"Thus the attachments of marine organisms, which are permanently rooted to the bottom or on the shore, did not differ in strength from those which we now find, an

indication that the strains due to the movements of the sea did not greatly differ in the past."

But have we any grounds for speaking positively on this point? Take, for example, the ligaments by which the Brachiopoda are attached to the sea bottom. We can measure the strength of the cable of an existing terebratula, but we have no means of testing the strength of the strand which anchored *Terebratula hastata* to the bed of the Carboniferous ocean. The actual cable is no longer there; it is a mere impression, a cast, or chemically altered. And certainly the anchored Mollusca—the Brachiopoda—were more numerous in the early geological ages than other classes, while they are comparatively rare at the present day.

Again, Professor Poulton brings forward evidence of a similar kind to show that movements of the air were not greater in the geological past. "We have evidence of a somewhat similar kind to prove uniformity in the movements of the air. The expanse of the wings of flying organisms certainly does not differ in a direction which indicates any greater violence in the atmospheric conditions."

Quoting the case of the island of Madeira, where an unusually large proportion of the beetles are wingless, and those which fly possess the powers of flight in a higher degree than those on continental areas, he leads us to the conclusion that if there had been greater air currents there would have been a like state of things in the geological past, with regard to winged creatures in general.

The evidence is rather slender for the conclusion which is built on it. For, as regards fossil organisms, it is the mere relative expanse of wing we have to go by. But suppose it was set us as a mechanical problem, "Given a flying organism, to fit it for more stormy conditions," how would we endeavour to solve it? Increase the size of its wings? That might only the better enable the wind to blow it away. Diminish them? That would curtail its powers of independent flight. The only solution would appear to be to increase the strength of the muscles, diminish the weight so far as consistent with strength, or alter the shape of the wings. All these things *may* have occurred in the ancient fliers.

Again, Professor Poulton quotes Professor G. Darwin to the effect that the size and strength of the trunks of fossil trees afford "evidence of uniformity in the strains due to the conditions of the atmosphere." But I maintain that, although we can measure the *size* of a *fossil*, we cannot from it accurately gauge the *strength* of the *living organism*. The original substance is no longer there, or there only in part. And we know from our existing vegetation how vast a difference there may be in the general form of the trees which are able to stand the present atmospheric strain. But this question of possibly greater atmospheric strain in the past does not seem to be of great importance, as no geologist who has protested against over strict uniformitarianism has laid much stress on it.

And besides tides and winds, there are other geological agents which *may* conceivably have been more active in the past.

(1) Rainfall. There certainly must have been a time when

evaporation — owing to greater heat of the earth, and consequently rainfall — was greater. Only if this state of things is shifted back beyond the period of the formation of our earliest stratified systems, can we escape the conclusion of greater geological activity in the past. And the greater the rainfall the greater the denudation, and consequent rock-making. This quicker formation, again, would probably not be shown in the rocks themselves.

(2) There may have been a larger amount of CO_2 in the atmosphere. In the original atmosphere of the globe there was probably a very large quantity of this gas. There *may* have remained in the atmosphere of the early geological ages an amount far in excess of the present supply.

(3) There may have been greater exuberance of life when the waters of the ocean were warmer, as they once must have been on the hypothesis of a cooling globe.

Greater rainfall, more CO_2 in the atmosphere, and a warmer ocean, all *must* once have been : they *may* have been late enough in time to affect the rate of deposition of the known stratified rocks. The question, then, really is, are we justified in putting them so far back as to make them anterior to the beginning of geological history? Those who are demanding more and more time must remember that the longer the period granted for the laying down of the stratified systems, the nearer we get to the epoch when the activity of geological agents *must* have been considerably greater than it is to-day. And if they *assume* that all the known stratified rocks were formed at the present slow rate of deposition, they leave unaccounted for the great series of strata which must have been laid down when geological activity was greater. They must appeal not merely to the imperfection of the record, but to its total absence so far as concerns the period before the present slow rate of deposition began.

Professor Poulton is at great pains thus to cut away the ground under the feet of the geologist who would "hurry up the process of rock formation." But even granting all that is claimed to have been proved, the biologist only gets in this way some 400,000,000 years. And this is so obviously too little that it seems hardly worth while to have troubled the geologist at all. Speaking of that curious organism *Peripatus*, which has been variously classed in the zoological scheme, Professor Poulton says:—"*Peripatus* is not known as a fossil. *Peripatus* has come down, with but little change, from a time, on a moderate estimate, at least twice as remote as the earliest known Cambrian fossil."

Now, if we put back the origin of *Peripatus* to a time as far anterior to the Cambrian as the Cambrian is to the present day, how far must we put back the origin of the simplest form of life? Well, *Peripatus* is a somewhat advanced organism—about the level of the insects—and on the assumption, approved by Professor Poulton, that evolution is slower among the simpler organisms we should perhaps place the first appearance of life on the globe as much before *Peripatus* as the origin of *Peripatus* is before the present. This places the commencement of life at a point four times as remote from

the present as the Cambrian. If, then, we take the period from Cambrian to present as 400,000,000, we get 1,600,000,000 years as the time during which there has been life on the globe. And there must have been a time anterior to this before life on a heated globe was possible. Yet Professor G. Darwin only allows 500,000,000 as the life of the sun!

Again, since we must suppose that rock formation began before life, what has become of the great series of pre-Archæan deposits which must have been laid down? Supposing for a moment that the Archæan rocks represent a period as long as from the Cambrian to the present, we have an interval as long as from the lowest Archæan to the present in which strata were being formed. Of this great series, which must have been, we know nothing. It is hardly conceivable that they should have entirely disappeared, leaving no trace behind. Time, we know, not only devoured his children, but also the stone offered in lieu of one of them. Yet we should hardly have supposed him capable of devouring quite so much rock.

Of course, no one can object to Professor Poulton, and those of like views, asserting that, on their hypothesis of the origin of the organic world, this or that organism must have existed so many million years ago, or at such and such a geological epoch. But if they are able, from the study of an existing form, to say positively that it must have existed at such a time, in spite of its entire absence in the known geological record—and even in spite of the absence of any geological record at all—it seems superfluous to appeal to geology at all. Biologists had better at once declare their entire independence. Professor Poulton practically does so. For after disposing of geology in the manner indicated he says: "We are therefore free to follow the biological evidence fearlessly."

One can only admire, while one wonders at, Professor Poulton's boldness. Geologists are yet sorely perplexed with the problem of the Archæan rocks. They have not yet definitely decided whether they are metamorphosed ordinary sediments, part of the original solidified crust of the earth, or chemical precipitates from a hot primitive ocean. Professor Poulton assumes, not merely that ordinary sedimentation, but *life* also was possible on the globe untold ages ere the earliest known pre-Cambrian rocks were laid down.

Darwin found Lord Kelvin with his 100,000,000 years an "odious spectre"; Professor Poulton apparently agrees with Butler that

> "There needs no other charm or conjurer
> To raise infernal spirits up but fear,"

and boldly waves back both geologist and physicist. He apparently adopts as his motto the advice of the Sybil to Eneas—

> "Tu ne cede malis; sed contra audentior ito
> Qua tua te fortuna sinet,"

which may be freely translated, "If facts go against you, *assume* the more boldly."

And so, having freed himself from both geological and physical evils, in the form of narrow balances at the bank of time, he holds himself free to go boldly where biological speculations permit. It is magnificent, but it is not science.

VII.—Eolithic Implements at Belfast and at Bloomsbury.

By F. J. Bennett, F.G.S.

MR. J. W. KNOWLES, M.R.I.A., of Ballymena, read a paper[1] on what appeared to him to be flints chipped similarly to the eoliths, which he had found in the Interglacial gravels of Ireland. This gave rise to a discussion, in which five speakers in succession gave reasons, or rather expressed opinions, adverse to their artificial character; and as these seemed based on some misconceptions, and also as I was the only one who spoke for them, and was told I must be brief, and so could not fully reply to them, I do so in the present form, and I state, as far as I remember, what took place in as few words as possible.

Mr. Knowles himself took a neutral position, but suggested that, if they were implements at all, they might have been used as scrapers for scraping hæmatite.

The objections were: that these so-called eoliths were found in such extraordinary numbers that they might be the result of natural causes, and that their upholders must disprove this; that the flints in question were those of the Clay-with-Flints, a deposit due to the chemical dissolution of the Chalk-with-Flints; that, if admitted to be artificial, they could not be older than the Palæolithic implements of the high levels, as they were both found in the same deposits; that similar flints were to be found in the Boulder-clay, and, as man was post-Glacial, that was a positive refutation.

Professor Boyd Dawkins, LL.D., F.R.S., took a prominent part in the discussion, and it was from him indeed that most of the objections came.

Replying to the objections, I would say that, as to their extraordinary numbers, "in countless thousands" as had been stated,[2] that might be expected from their very rudeness. If these are the very earliest tools of the earliest men we should, on evolutional grounds, expect them to range from natural forms (selected in their

[1] Paper read before British Association, Belfast, Sept. 1902.

[2] The new pit sunk by Mr. Harrison and myself last year at Parsonage Farm, Ash, confirms most fully those sunk in 1894. I took a careful note of the percentage of worked as compared with the unworked stones, and this varied from 4 to 9 per cent.; out of the many 'cart-loads' of stones got out the worked stones would not make even one barrow-load, and as a matter of fact this pit, sunk $12' \times 8' \times 5'$, only yielded some 200 specimens. I understand that to the Eoliths exhibited at Bloomsbury a label is attached with these words, "Supposed to be the work of man." Now this might lead many to assume that the Palæoliths were undoubtedly the work of man, and yet there is no *real proof* of this, and the same words *might* apply to both Eolithic and Palæolithic implements (so-called).

first stages as adaptable to man's primitive needs, when first conscious that some tool as an adjunct to the hand would be a useful supplement to that member) to modifications by rude chipping of that natural form into more and more artificial forms; and these gradations are of course very difficult to follow. This renders it necessary that no opinion should be formed unless a large series of these so-called implements has been examined, such as Dr. Blackmore's at Salisbury (which converted two of my late colleagues) and Mr. Harrison's at Ightham. The latter, *none* of the objectors had seen, though by some misunderstanding the Section thought they had. As to their being all due to natural causes, such as ice-pressure, wave and river action, this objection has been very fully met by the late Sir Joseph Prestwich in his letter "Nature and Art," in the Geological Magazine, Dec. IV, Vol. II, No. 374, p. 375, August, 1895. There he repeats a former challenge for anyone to produce half a dozen shore-flints of any of the plateau types figured in the five plates that he published in his "Collected Papers," and no one has yet produced these.

Still, I might add, undoubted palæoliths have been found in beds where all these causes have had full play; not so certain, indeed, in the case of ice-action, though implements with parallel striæ similar to ice-markings are not uncommon; and where waves, as in the case of the Palæolithic implements found at the base of sea-cliffs, have bruised and battered them, man's work stands out still, and the same remark applies to implements found in the river-gravels. Besides this, no one has yet made a collection similar to Mr. Harrison's, of ice-, wave-, or river-formed specimens. As to the statement that they are similar to the flints (and this is what Professor Boyd Dawkins meant, I suppose) of the Clay-with-Flints, none have been found in this deposit; they are found in a distinct gravel-bed, at an altitude of 755 feet O.D. Then, as to the statement that Palæolithic implements are found in the same deposits as the high-level Eolithic implements, it is true that in one or two instances a Palæolithic implement was dug up, but how or when is not known. On the contrary, the evidence of the two pits sunk by Mr. Harrison in 1894, with the grant made by the British Association, shows that the gravel-bed at $7\frac{1}{2}$ feet yielded a considerable number of Eolithic implements only, and the five additional pits sunk by Mr. Harrison to satisfy himself confirmed this. The objection that, as man is post-Glacial, therefore he cannot be pre-Glacial, is a mere dogmatic assertion. Again, the stony loam, the first bed met with in the above pits, cannot surely be Clay-with-Flints, as it rests on a gravel-bed, which lies on 27 feet of Tertiary beds, and *not on Chalk*, as Clay-with-Flints should.

Thus, I think that all the objections have been fairly considered and met.

But in spite of the opposition to the acceptance of the eoliths, Mr. Harrison and his supporters must be gratified to find them occupying so important a place in the recent Geological Survey Memoir on Sheet 314 of "The Geology of the Country around

Ringwood"; also in the British Museum, Bloomsbury, and Mr. C. H. Read's "Descriptive Guide to the Stone Age." In this Guide (an otherwise carefully written work) no provisional place has been given to the eoliths *before* the palæoliths in the classification, and the mention of these appears in the *middle* of the Palæolithic period; this must lead to confusion. Mr. Read seems impressed by the eoliths, and treats them most fairly, though it is very unfortunate that, while all the other illustrations are well done, the eoliths at p. 37 show in their drawing only feeble evidence of 'work.' Mr. Read, at p. 33, refers to the important collection of Eolithic implements from Sir Joseph Prestwich's collection in the Natural History Branch of the British Museum at South Kensington. This should be carefully studied as additional illustrations of the Stone Age.

REVIEWS.

I.—Recent Excavations at Stonehenge, communicated to the Society of Antiquaries by William Gowland, Esq., F.S.A., F.L.S., etc. With a Note on the Nature and Origin of the Rock-fragments found in the Excavations, by Professor J. W. Judd, C.B., LL.D., F.R.S., F.G.S. 4to; 93 pages, with 4 plates and 29 text-figures. Printed by J. B. Nicols & Sons, Victoria Street, Westminster, 1902.

THE Antiquary and the Geologist have individually for many years past published their observations on Stonehenge, and their notions about its origin and structure; but now, in actual co-operation, they have united to give a real description and sound opinion of this venerable monolithic monument of ancient labour and intelligence. With the consent and generous help of the Owner, the valuable assistance of willing experts, and the utilization of any useful information from among the already published notes, a great mass of authentic particulars has been thus collected and arranged to a good purpose.

The descriptive text (forming part of the Society of Antiquaries' Archæologia for 1902) is admirably printed, with numerous illustrations, several of which are produced from excellent photographs taken during the operations and kindly lent by a lady of the neighbourhood. Every stage of the excavations made around the foot of the prominent and well-known 'leaning stone,' which had to be restored to its original vertical position, as it was when a part of the chief Trilithon, has been described and figured in detail. Thus one of the chief objects of this important engineering undertaking has been carefully worked out. Another object to be attained was the realization of some definite history of the great standing stones of Stonehenge, as far as the relative number, position, and characters of the blocks and chips of the various kinds of stone got from the diggings can prove anything as to the cause, method, and time of their imbedment in the subsoil.

The large monoliths of the outer circle and the trilithons of the 'Horse-shoe' are of the well-known Sarsen Stone, namely, relics of concretionary masses of Tertiary Sandstone (probably of the Bagshot Sands, which once lay over the Chalk). They range in their structure from granular (saccharoid) to compact and quartzitic denseness. Sarsens having the latter character were found only in the diggings, as blocks and hammer-stones, used in shaping and dressing the monoliths, or as fragments of such hammers.

The small monoliths, commonly called 'the Blue Stones,' and forming the inner circle and the inner horse-shoe, consist of aqueous, schistose or metamorphic, and sedimentary rocks. At pp. 73–78 (1) the Sarsen Stones and their constitution are fully treated of by Professor Judd. (2) Ophitic diabase (p. 74) has been recognized, with varieties, in fragments and in a still standing stone. (3) The schistose and fissile rocks are highly altered basic tuffs and agglomerates (p. 74); their fragments are numerous, but only the stump of one of this sort of stone has escaped the action of weathering and other destructive agencies. (4) Fragments of altered rhyolites and diorites (p. 75), formerly often referred to as hornstones, etc., present various characters not readily determined, and indicate the former existence of a stone of this material. (5) Sandstone, grit, and conglomerate, including the micaceous sandstone of the 'altar-stone,' and probably equivalent to the Coronation Stone in Westminster Abbey, from the Old Red Sandstone of Perthshire, occur among the fragments. (6) Greywackés (p. 76), that is, granular quartz and altered felspar, with argillaceous matter, among the fragments, show that stones of such material were present, but probably were easily weathered away. (7) Argillaceous flagstones and slate (p. 76) must have been among the standing stones, but were completely weathered away, especially when their bed-planes and cleavages were set vertically. (8) Glauconitic sandstone (p. 76), probably of the Upper Greensand, occurred in a few fragments. (9) Flint, from the neighbouring Chalk (p. 77), was present as very numerous rough chisels and hammers, and the chips and fragments of such tools. Some small hammers of crystalline rocks and quartzite (hard sarsen-stone) were also found, and several large masses, the weight of which (upwards of 50 and 60 pounds) and the probable method of using them are given (p. 34).

The stone implements found at Stonehenge are carefully figured (23 of flint, 7 hard sarsen, and 1 argillaceous sandstone) at pp. 22–25; they are mostly blunted and battered by use. Flint tools corresponding in shape from Grimes Graves and Cissbury are figured at pp. 27–28.

Important observations are made (at pp. 37, etc.) on the modes of erection and the probable age of Stonehenge. The finished surfaces of all the Sarsens, where preserved, had been tooled with hard hammers, and the markings cannot be produced by present mason's tools (p. 43). The methods by which the great monoliths were set up and secured in the ground were shown in detail during the excavations as far as gone (pp. 44–48). The legend of the

'Blue Stones' having been brought from a distance and set up as a sacred circle, and the supposition that the Sarsens were added afterwards around them, are disproved by evidence of their contemporaneity, by the mode of occurrence of the chippings, and of the stones themselves.

The use of bronze was unknown before 1800 B.C., and there were no bronze tools found in the diggings. Mr. Gowland is therefore inclined to consider that Stonehenge was raised before the incoming of the Bronze Age at the above date. This nearly approximates with the result of the important astronomical investigation by Sir Norman Lockyer and Mr. Penrose as to the relative position of sunrise at the summer solstice and the probable age of Stonehenge.

Professor Judd, in his clear and comprehensive description of the stones of Stonehenge (pp. 70 et seq.), gives the bold but well-founded suggestion that all the stones once lay about on the surface of the district. The Sarsens, being the concretionary relics of the denuded Bagshot Sands, were large and abundant. The 'Blue Stones,' of smaller size and of various characters, were relics of the glacial Boulder-clay, which reached in the Southern Counties further than is usually described. The presence of similar rocks in the gravels of the rivers of the South of England, including those that drain Salisbury Plain, support this opinion. The absence of such rocks, foreign to the district, on the surface now, may be well accounted for. The softer rocks were gradually weathered away, and the harder kinds were continually being used for local purposes, like the existing scattered Sarsens in Berks and Wilts. These 'Blue Stones' were, moreover, evidently dressed on the spot when taken to the circle, for their chippings are more numerous than those of the Sarsens in some of the diggings. T. R. J.

II.—Egyptian Geology.

Survey Department, Public Works Ministry, Egypt. Geological Survey Report, 1900. Part II: The Cretaceous Region of Abu Roash, near the Pyramids of Giza. By Hugh J. L. Beadnell, F.G.S. 8vo; 48 pp., 13 pls. (Cairo, 1902.)

THIS is an attempt to give an adequate description of the geology of a small area lying to the west of Cairo. It is a district that has received the attention of many observers before, as Mr. Beadnell is careful to record in his historical sketch which forms an introduction. The report is accompanied by a geological map, which the author tells us is sufficient for present requirements. It is not possible for anyone who has not been over the ground to criticize the details of the stratigraphy, but it appears to have been carefully done, and numerous detailed sections are given which should render the work of great value to future observers. The author, too, has a topographical knowledge which is so exact as to allow him to write in a more interesting manner than is usual in official reports. It is a matter for regret that those who are engaged in a geological survey of a country do not also enjoy the advantage of some special

palæozoological training. It is, as a rule, difficult for a surveyor to properly decide the exact age of the rocks among which he is working, unless he is himself able to name his own collections. We know that this was not formerly considered necessary even on the Geological Survey here at home, and much of the confusion of age which has arisen in various places is doubtless due to this indifference to the high importance of a constant reference to palæozoological guideposts and zone-marks. The system which demands that one man shall map everything from Archæan to Recent doubtless debars many geologists from anything more than a superficial acquaintance with fossils in the field, but that it is a necessary consequence is disproved by many well-known Continental names.

The report is illustrated in an admirable manner, and plates iii and vii (collotypes) are perfect, and show that Mr. Beadnell is also an expert photographer. The three plates of wind-worn pebbles are photogravures and excellent, but such ordinary objects seem scarcely worthy of the expense incurred; certainly one plate would have sufficed.

The Director-General of the Egyptian Survey and his staff may well be proud of the stratigraphical results of their labours; and in gracefully accepting the special knowledge of fossil forms afforded them by Dr. Andrews, Mr. Bullen Newton, Professor Gregory, and others, they cannot fail to enhance the high scientific value of the palæozoological results obtained in this most interesting and ancient country. C. D. S.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—January 21st, 1903. — Professor Charles Lapworth, LL.D., F.R.S., President, in the Chair. The following communications were read :—

1. "The Figure of the Earth." By William Johnson Sollas, M.A., D.Sc., LL.D., F.R.S., F.G.S., Professor of Geology in the University of Oxford.

The almost precise correspondence of great terrestrial features with a circular form seems to be frequently overlooked. The Aleutian curve has its centre in lat. 6° N., long. 177° W., that of the East Indies about 15° N. and 118° E., and round the latter centre are several concentric curves. The northern part of South America, the Alpine-Himalayan chain, the western shore of North America, and a portion of Australia may be similarly reduced to geometric form. A great circle swept through the centres of the East Indian and Aleutian arcs runs symmetrically through the bordering seas of Asia as far as Alaska, borders the inland lakes of America, passes the Californian centre, extends through the middle of the Caribbean Sea, runs parallel with the coast of the Antarctic Continent, and returns to the East Indian centre without touching Australia. This course is in remarkable correspondence with the general trend of the

great zone of Pacific weakness. If the pole of this circle in the Libyan Desert is placed towards an observer in a globe, the African Continent appears as a great dome surrounded by seas and separated from the Pacific by an irregular belt of land. A second great circle defined by Lake Baikal, and with its centre at 'the morphological centre of Asia' of Suess, and passing through the East Indian centre, may be regarded as the direction-circle for the Eurasian folding. These two centres intersect at an angle of 39°, and, on bisecting this angle, a mean directive circle is found, with its pole near the sources of the White Nile, 6° north of the Equator. The axis of terrestrial symmetry through this pole passes through the middle of Africa and of the Pacific Ocean. The smallest circle which will circumscribe Africa has its centre near this pole, and within it the symmetry of the fractured African dome is observable. Outside this comes a belt of seas, and outside that again the Pacific belt of continents, the Antarctic, South America, North America, Asia, and Australia. Mr. Jeans has concluded on mathematical grounds that the 'pear-like shape of the earth' might have been possessed by it at the time of its consolidation; and he has suggested that Australia may represent the 'stalked end' of the 'pear.' The author's observations would lead him to place it in Africa, and to regard the Pacific as covering the 'broad end.'

2. "The Sedimentary Deposits of Southern Rhodesia." By A. J. C. Molyneux, Esq., F.G.S.

The greater portion of the area of Southern Rhodesia lies on granite and gneiss, and on the schists and slates that contain the auriferous veins worked in ancient times, and now being again opened up on an extensive scale. The remaining area is on sandstone and other sedimentary beds, with coal-deposits, and regions of volcanic rocks. To explain the deposition and order of these sediments several sections are given; one being along a line extending from the Zambesi River on the north, through Bulawayo and the central plateau, to the Limpopo River on the south, a distance of over 400 miles. Another section, with remarks thereon, is copied, by permission, from a report by Mr. C. J. Alford, F.G.S., on the coal-bearing rocks of the Mafungibusi District.

From Bulawayo fine sandstones continue for about 170 miles to the north, when there is a sudden drop in the surface of the country, caused by a long line of cliffs of red sandstone, which extends from the Zambesi Falls Road right across this portion of Rhodesia, and finally merges into the Mafungibusi Hills far away to the north-east. This is the great escarpment, formed by the erosion of 400 feet of coarse grit with angular pebbles. To the north-west of this escarpment, and running parallel with it, is a long and narrow valley formed of soft shales which are known as the Matobola Flats. Here the beds dip at 5° south-eastward. Thus, in proceeding further to the north-west, underlying beds are revealed, with a lower series of Coal-measures containing seams of workable coal. Below the Coal-measures are quartzites and current-bedded grits, which rise up and form the Sijarira Range, a flat plateau 15 miles across. Its

north-western side, however, is almost precipitous, and is capped by folds of quartzites. There is a drop of 1,100 feet in a few miles, and the rest of the country is almost flat as far as the Zambesi River. To the west is the gorge of the Lubu River, and it is there seen that the sediments rest upon pegmatites and gneiss.

Another section shows the contact of fine sediments and metamorphic rocks down the railway-line to the south-west past Sisi siding, where certain plant-remains were found. By these sections the boundary or line of unconformity is traced from the Mafungibusi district, round the promontory of granites and shales which form the backbone of Matabeleland, to the Tuli district and Sabi River on the south. Except in the Tuli district, where an unconformity between the veined sandstones and the Coal-measures is noticed, there are no definite breaks in the order of stratification; and it is by the general arrangement of superposition and characteristic features that the strata fall into certain groups. No attempt is made to correlate the strata with the Cape and Karoo systems; and for the present the author gives the following provisional classification:—

		Thickness in feet.
Taba 'Sinduna Series	Sandstones and volcanic rocks	200
Forest Sandstones	....	1000
Escarpment Grits.....	.....	400
Upper Matobola Beds (fossiliferous).	Coal-measures.....	300
Busse Series ..... (fossiliferous).	Sandstones and grits	300
Lower Matobola Beds	Coal-measures.....	200
Sijarira Series	Quartzites and current-bedded sandstones	2000

Great unconformity.

Basement-rocks: Gneiss, schists, and pegmatites of Mafungibusi and Lubu.

Fossils have been found in the Coal-measures, comprising mollusca, plant- and fish-remains, which are described in appendices. These indicate the age of these beds to be Permo-Carboniferous.

The Coal-measures yield coal of excellent quality, and the areas in which seams outcrop, or have been developed, are described under the names of the Mafungibusi, Sesami, Sengwe, Lubu, Sebungu, and Wankies Coalfields in the north, and the Tuli and Sabi Coalfields in the south.

Reference is made to the numerous mineral springs, of varying temperature, that are dotted along the Zambesi Valley, and to mounds of travertine, containing recent fresh-water and land shells, that have been accumulated by extinct springs.

Volcanic rocks are well displayed in a long area extending from Macloutsie to the Bubi River, 200 miles; and the extinct craters are still recognizable at Fort Tuli, which gives the name to this tract of Tuli Lavas. Sheets of basalt are interbedded with the Forest Sandstones at the Bubi and Gwampa Rivers; and at a portion of the escarpment above the Sesami Coalfield, basalt forms a capping and extends back about 24 miles.

Three appendices are added: one, on a New Species of *Acrolepis*

from the Sengwe Coalfield, by A. Smith Woodward, LL.D., F.R.S., F.G.S.; a second, on some Lamellibranch Mollusca, by Wheelton Hind, M.D., F.R.C.S., F.G.S.; and a third, on some Fossil Plants from Rhodesia, by E. A. Newell Arber, M.A., F.G.S.

II.—February 4th, 1903.—Professor Charles Lapworth, LL.D., F.R.S., President, in the Chair. The following communications were read:—

1. "The Granite and Greisen of Cligga Head (West Cornwall)." By John Brooke Scrivenor, Esq., M.A., F.G.S.[1]

The small granite mass between St. Agnes and Perranporth has been described by Conybeare, Carne, Sedgwick, Foster, and others. It is a remnant of a much larger mass which has been partly denuded by marine action and partly hidden by a north-and-south fault. It is possible to distinguish two divisions of it; the main mass and the 'tongue,' throughout both of which 'bedding' is well developed. The granite bordering the bedding-planes has been altered into greisen, which, owing to the abundance of quartz, appears in the cliff-section as dark bands. Each greisen band contains a quartz-vein, marking the original fissure along which metasomatism took place; the veins contain tourmaline, cassiterite, wolfram, mispickel, and chalcopyrite. Two main reactions appear to have taken place in the formation of the greisen; the felspars affording topaz, muscovite, and secondary quartz; the biotite, brown tourmaline, magnetite, and secondary quartz. The fact that no tourmaline has been formed from the felspar, owing to the presence of abundant fluorine, distinguishes this greisen from luxullianite and trowlesworthite. The blue tourmaline prisms included in original quartz appear to have been original constituents of the granite. Secondary quartz, deposited in optical continuity with the original grains, has also caused them to appear to have a crystal outline. The fluorine and boron had not so great an effect on the extremity of the tongue as on the main mass, as shown by the poor development of greisen and the freshness of the biotite. Mica, topaz, and microcline-perthite have been redeposited there by percolating water or vapour. The greisen is an example of Professor Vogt's 'pneumatolytic' action in thoroughly acid rocks, resulting in the formation of tinstone lodes, as contrasted with the similar action in syenitic rocks with the production of zircon, etc., and in basic rocks with the production of chlor-apatite and the scapolitization of the felspar.

2. "Notes on the Geology of Patagonia." By John Brooke Scrivenor, Esq., M.A., F.G.S.

The author was travelling in Patagonia from September, 1900, until March, 1901. The sedimentary strata consist of Tertiary, Cretaceous, and Jurassic formations, which, with the exception of the Jurassic, yield interesting and varied faunas, both vertebrate and invertebrate. The latest classification is that drawn up by Mr. J. B. Hatcher, who conducted the expeditions sent from

[1] Communicated by permission of the Director of H.M. Geological Society.

Princeton University. Mr. Hatcher, aided by Dr. Stanton and Dr. Ortmann, has arrived at the following correlation :—

Shingle Formation (Téhuelche Pebble-bed)	Pleistocene.
Cape Fairweather Beds	Pliocene.
Santa Cruz Beds	Upper Miocene.
Patagonian Beds	Lower Miocene and Upper Oligocene.
Upper Lignites	Middle Oligocene.
Magellanian Beds	Lower Oligocene and Upper Eocene.
Guaranitic Beds Lower Lignites Variegated Sandstones Upper Conglomerates Belgrano Beds Lower Conglomerates Gio Beds	... ... Cretaceous.
Mayer Shales	Jurassic.

Except in the north, where intrusions of an acid type have disturbed the sediments, the southerly dip is so gentle as only to be appreciable where sections can be followed for some distance. Mr. Hatcher considers that an unconformity separates the Magellanian and Guaranitic Series, also the Cretaceous and Jurassic.

Excellent sections of the Patagonian Beds were seen on the Santa Cruz River and in the coast-section at Monte Leon. They are littoral deposits, consisting of sandstones and mudstones. Calcareous nodules are frequently arranged along the bedding-planes. Petrologically the sandstone is remarkable for containing fresh hypersthene and plagioclase. At Monte Leon the top of the Patagonian Beds is marked by gypseous mudstones and a shell-bed. These are succeeded by estuarine beds, some of which yield impressions of *Fagus*. Conformable on the estuarine beds are the famous Santa Cruz Beds, which have yielded a rich vertebrate fauna. They consist chiefly of pumiceous mudstones, with a little hypersthene; but a blue clay alternates with the mudstones, and there are also two bands of *Ostrea ingens*, and one or two of ferruginous sandstone. The Téhuelche Pebble-bed passes down into the Cape Fairweather Beds imperceptibly; otherwise it overlies everything unconformably.

Very little is known of the igneous rocks. Apart from those of the Cordillera, there are vast plateaux of basalt and intrusions of quartz-porphyry. A good example of the latter occurs at Port St. Helena. The specimens of igneous rocks collected from the moraines of the Cordillera comprise biotite-granite, hornblende-granite, quartz-mica-diorite, gabbro, hornblende-picrite, quartz-porphyry, rhyolite, obsidian, ophitic olivine-dolerites, olivine-basalts, and acid tuffs.

The basalt-flows cover an enormous area. They slope gently towards the Atlantic, and are cut off from the Cordillera by a longitudinal depression. In the neighbourhood of Lago Colhuapé there seems to have been a distinct centre of eruption, apart from that which commences nearer the Cordillera. All that can be said of their age is that they are older than the transverse depressions of the Cordillera, and older than the glaciation of the eastern slopes of that chain.

The Téhuelche Pebble-bed, which covers nearly the whole of Patagonia, has been ascribed to marine action by some authors, by others to glacial action. A third suggestion is the agency of big rivers. No one of these agents alone could have produced the observed phenomena; the origin was complex. The bulk of the material was brought by glaciers from the Cordilleras to the sea, which then covered the greater part of the pampas. As the sea receded, it distributed the pebbles over the bottom, so forming a continuous layer, such as now exists between the eastern coast and the Falkland Islands. Torrents resulting from the melting of the glaciers assisted in distributing the material from the Cordillera. Part of the material on the present eastern coast was derived from islets of quartz-porphyry in the Pleistocene sea. A great difficulty is that no basalt-pebbles are found at Santa Cruz east of the flows.

The drainage system includes several eastward-flowing rivers and numerous lakes, some of which occupy transverse valleys cutting through the Cordillera. An example of the latter is Lago Buenos Aires. The history of this lake can be gathered from the evidence observed on its shores. Lagos Musters and Colhuapé are two other interesting lakes near the eastern coast. The width and depth of the river-valleys are disproportionate to the present streams; this can be explained by a decreasing rainfall, and also by the diversion of many tributaries to the Pacific. Some valleys are dry, as, for example, the Great Cañadon Salado.

3. "On a Fossiliferous Band at the Top of the Lower Greensand near Leighton Buzzard (Bedfordshire)." By George William Lamplugh, Esq., F.G.S., and John Francis Walker, M.A., F.L.S., F.G.S.

This paper describes a newly discovered fossiliferous band at the top of the Lower Greensand, overlain by the Gault, in the sand-pits at Shenley Hill, near Leighton Buzzard, in Bedfordshire. The fossils of this band present a different facies from that of any other previously known fossiliferous horizon of the Lower Greensand, and show closer affinities with the fauna of the Upper Greensand than have hitherto been recognized in any deposit below the Gault. The Brachiopoda are closely allied to those contained in the Tourtia Beds of Belgium. The fossiliferous bed is rather sharply marked off from the underlying unfossiliferous 'silver-sands,' but is still more sharply marked off from the overlying Gault. Stratigraphically it forms part of the Lower Greensand, and cannot (without violence to the accepted classification of the deposits) be considered to belong to the Gault. The fossils constitute the newest Lower Cretaceous fauna as yet recognized in England. Several species, hitherto supposed to be confined to the Selbornian, are now shown to have been in existence before the deposition of the Gault. The lithological characters of the bed indicate a sea-bottom of moderate depth, swept by powerful currents, and the conditions were thus similar to those which persisted in the neighbourhood throughout Lower Greensand times. The overlying Gault shows a change to more tranquil waters, probably of greater depth.

CORRESPONDENCE.

QUARTZ DYKES NEAR FOXDALE.

Sir,—Though I have not visited Foxdale in the Isle of Man, I venture to express a doubt whether Mr. Lomas (p. 34) has succeeded in proving its quartz dykes to be igneous rocks. 'Dykes' and veins of that mineral are common in many countries, and cut almost all kinds of rock, though, as might be expected, they are rather rare in the more igneous or basic limestones. Sometimes the dykes attain a considerable thickness and may be traced for a long distance; at others veins run off into the finest threads, and their demeanour is unlike that of an igneous rock, from which they are often far away, and their abundant fluid cavities and consequent whiteness (as described by Mr. Lomas) suggest that they have been formed from water. That silica, both crystalline and colloid, is so deposited, especially from hot springs, is well known (see, for instance, a very important paper by the late Mr. J. A. Phillips, published in the Quarterly Journal of the Geological Society, vol. xxxv, p. 390). The fact that at Foxdale quartz veins traverse the granite in itself suggests they are later in origin and formed by thermal waters, with which their occasional relation to dykes of microgranite is quite consistent. Mr. Lomas appears to regard the fact that the veins on entering the granite change locally into pegmatite as strongly in favour of his hypothesis. But the presence of felspar or even mica in a vein does not prove it to have had an igneous origin. I have examined numbers of quartz-felspar-mica veins in gneissoid rocks which seemed to differ in important respects from granite. Sometimes, though by no means always, they have been affected by the pressures which have produced the schistose structure; but the three minerals are usually associated in a clotted and irregular fashion, very different from that characteristic of rocks which have solidified from a molten condition, and their structure frequently is abnormally coarse, even in comparatively thin veins, where a true igneous rock would be almost invariably either compact or not more than micro-granular. The most remarkable case of mineral grouping which I have seen was in the neighbourhood of Svolvaer in the Lofoten Islands. Here a coarse gneissoid rock was cut by a quartz vein, varying irregularly in breadth from two or three feet to as many yards. By its side, and in places mixed with it, were a fairly broad band of felspar and a much narrower one of a dark ferromagnesian mineral, which at the time, more than thirty years ago, I took for a pyroxene. The quartz was white and curiously divided by sharp joints into parallelepipeds, rather variable in size. If, then, this was an igneous vein, there must have been three distinct ejections (only locally mixing) of quartz, felspar, and a ferromagnesian mineral (not necessarily in the order of enumeration). The pegmatite of the Foxdale vein, according to Mr. Lomas, contains felspars, some over three inches long, perfectly formed, and showing crystal faces. But the latter habit (except when there is considerable difference between the fusion point of a mineral and the residual

magma) is far more indicative of formation by water, and is not usual in pegmatites, so far as I know them; if, indeed, all these are igneous rocks. Mr. Lomas, however, may reply that he does not assert all quartz veins, even if including felspar and mica, to be igneous, but only that at Foxdale. But if so, we may fairly ask him to tell us how to distinguish igneous from aqueous veins. The former, when they cut through sedimentary rock, especially if it be argillaceous, generally produce rather conspicuous structural and mineral changes, so that here I expected Mr. Lomas to give a careful description of the contact-metamorphism or to offer an explanation of its absence. Instead of this I find only the vague phrase 'altered slate'—a phrase compatible with slight silicification or other changes such as may take place by ordinary infiltration, and thus be no help to his hypothesis. I do not deny that differentiation might possibly be carried so far in an ordinary acid magma as to leave a residuum of pure or nearly pure silica (though I have never met with an instance of it), but I think it more probable that, as Mr. Lomas substitutes at critical points vague phrases and inconsequent statements for precise description, he has yielded to the fascination of a novel hypothesis.

P.S.—The above was written before the publication of Mr. Harker's letter (p. 95). T. G. Bonney.

THE ORIGIN OF QUARTZ-VEINS.

Sir,—In connection with the question of the origin of certain quartz-veins,[1] the fact that quartz reveals plastic qualities at temperatures considerably below the melting-points of many undoubted igneous minerals must be born in mind. J. Joly.

Trinity College, Dublin.
February 9th, 1903.

NEW GEOLOGICAL TERMS AND FALSE ETYMOLOGY.

Sir,—As no one seems inclined to protest against the terms 'calcrete' and 'silcrete' with which Mr. Lamplugh proposes (in your December number[2]) to disfigure geological nomenclature, I must even raise a voice in the desert. Brief expressions for what he intends them to convey would doubtless be useful, and no one would be likely to quarrel with 'calcicrete' and 'silicicrete,' of which one would be two, the other three, letters longer. I admit that public convenience may sometimes prevail over strict etymological rules, as in preferring the inaccurate 'telegram' to 'telegrapheme'; but 'calcrete' and 'silcrete' are even worse than the fashionable mongrel 'peneplain,' and approximate in malformation to the hideous 'phenocryst,' which seems invented to signalize the divorce of geology from culture. T. G. Bonney.

THE DEHYDRATION OF LATERITE.

Sir,—The very interesting paper on "The Constitution of Laterite," by Mr. T. H. Holland, appearing in your issue for February, 1903, raises several questions of chemical physics which

[1] See Mr. J. Lomas's article, Geological Magazine, January Number, p. 34, and Mr. Alfred Harker's letter, February Number, p. 95.

[2] Geol. Mag., December, 1902, p. 575.

are of the utmost importance from a geological standpoint. That crystalline affinity is a definite molecular force accompanied by exothermic changes is doubtless correct, but whether this force can determine chemical changes of an endothermic character is a question involving an entirely new conception, and requires careful consideration before it can be accepted as a reasonable hypothesis. More especially is this the case when we have to deal with the constitution of hydrates, which afford such excellent examples of the application of the phase rule in chemical physics. Hydrates, as is well known, have a vapour pressure of their own, and only continue to exist when in equilibrium with the vapour pressure which they have to support. Thus the hydrates of copper sulphate can be successively decomposed under varying conditions of temperature or pressure. The instability of the aluminium hydrate, $Al_2O_3 . 3 H_2O$, at moderate temperatures, also, is a fact well known in chemistry; and it seems probable that the occurrence of any hydrate, either of aluminium or of iron, in nature will depend upon which happens to be the stable phase under the existing conditions of temperature and pressure.

In connection with the crystallization of alumina the researches of W. Spring, of Liège, appear to have some bearing. According to this observer, amorphous alumina or ferric oxide, if damp, can be rendered compact, presumably with the occurrence of an incipient crystallization, by pressure alone; and we are induced to consider whether the amorphous state in solids may not, in some cases at least, be comparable with the condition of superfused solutions and glasses. In fact, many of the distinctions between solids and liquids are gradually breaking down under the researches of modern physics.

There does not, therefore, appear to be any necessity for a new theory to explain the facts in this case. It appears rather that Mr. Holland has unnecessarily introduced a difficulty by presupposing that the molecules in laterite are isolated from extraneous energy. If this were really the case there could be no change of entropy such as he describes, and rightly, to be the result of the reactions involved.

J. Vincent Elsden.

38, St. Stephen's Gardens, Twickenham.

THE COLOUR OF GLASLYN AND OF LLYN LLYDAW.

Sir, — Glaslyn and Llydaw are the names of the two chief Snowdonian tarns. Glaslyn has been noted from time immemorial for the greenish colour of its water, as is implied by its name; but until the Summer of 1899 there was nothing peculiar about the colour of Llydaw. During that Summer, however, for the first time within the last fifty years at least, the water of Llyn Llydaw became as green as that of Glaslyn. The cause of this remarkable change of colour is not far to seek; for in the Spring of 1899, some time about March I am told, the company that works the Snowdon Copper Mine commenced crushing and washing their ore on the bank of Llydaw, so that a large quantity of greenish débris was

and is daily carried into the lake, whose water has thus become turbid and greenish in colour. The rock excavated along the copper veins is of a greenish colour, as may be seen by looking at the tips from the adit-levels.

This change of colour in Llydaw explains the colour of Glaslyn, about the cause of which there has hitherto been some doubt. For it cannot now be doubted that Glaslyn owes its green colour to the detritus of green rock washed into it from the adit-levels of the mines. J. R. Dakyns.

P.S.—I should say that the mines are situated immediately above Glaslyn.

Snowdon View, Nant Gwynant, Beddgelert.
January 21*st*, 1903.

THE TERM 'HEMERA.'

Sir,—Mr. Buckman appears to think that stratigraphy is nothing but geological chronology i.e., that it is chiefly concerned with the days and weeks of geological time, and that the actual sequence of rocks is of less importance.

He will not admit that his definitions of the term hemera, or his correlation-table of zones and hemeræ in Quart. Journ. Geol. Soc., vol. xlix, p. 519, are open to misconstruction, and yet he complains that most of those who have essayed to use his term have misunderstood the meaning he intended to give it. It now appears that in that table he was giving us a geological calendar, and not an ordinary correlation-table of rock-subdivisions.

The real fact is that Mr. Buckman gave a name to an abstract idea relating to a thing which had no definite name at the time when he wrote. His paper was a stratigraphical one, and he cannot deny that he was actually dealing with the subdivisions of zones, yet, instead of proposing a name for the small subdivisions which he recognized in the sequence of deposits, he gave a name to the time occupied in the formation of each subdivision; in other words, he saw no necessity to give a name to the thing itself, but only to the geological day or week in which it was formed.

He asserts that he was giving a name to the duration of a zone, but this assertion is inconsistent with his original definition of a hemera; he says, "successive hemeræ should mark the smallest consecutive divisions which the sequence of different species enables us to separate in the maximum developments of strata." Now, a zone is not the smallest possible subdivision of a series of beds, and Mr. Buckman's own tables show that he knew it was not, for they show that it took the time of two or three hemeræ to form one zone. Hence, if a hemera is anything at all it is not the duration of a zone, but of some subdivision of a zone.

The only point that Mr. Buckman has made quite clear is, that he will not have his term 'hemera' used as the name of a rock-division, but he has not clearly indicated with what recognized subdivision of a stage he wishes the term to be connected. If he makes any reply to this letter, let him state clearly whether he accepts the term subzone,

and whether he intends the word hemera to denote the duration of a subzone. If he does, then I can safely promise that he shall not in future be annoyed by my misuse of the term, for I will take care never to use it except on those infrequent occasions when I want to express the time during which a certain subzone was formed. My chief concern is with the actual stratigraphical unit and the fossils which it contains; a name for the time-unit may be convenient, but is of quite secondary importance. Hence his *reductio ad absurdum* does not trouble me.

A. J. JUKES-BROWNE.

TORQUAY, *February 4th*, 1903.

OBITUARY.

HENRY STOPES.

BORN FEBRUARY 17, 1852. DIED DECEMBER 5, 1902.

WE regret to record the death, on December 5th, 1902, of Mr. Henry Stopes, for many years a Fellow of the Geological Society of London. He was born at Colchester on Feb. 17th, 1852, and it was perhaps his early association with that ancient place which turned his thoughts to antiquities. When a boy of 8 he found a fossil *Echinus* in the playground gravel, and after seeking in vain from all he met an explanation of its peculiarities, he took it to bed with him, that he might meditate at leisure in the morning over its meaning. For this he was punished, but the punishment only intensified his interest, and he kept that stone, which became the nucleus of a large geological collection. He early brought together a fine series of Essex Crag shells, part of which is now on loan at the Stratford Museum. While collecting this, he received from a friend, a fellow-collector, a specimen of *Pectunculus glycimeris*, which the latter had himself taken from the Red Crag at Walton-on-the-Naze, with a rude carving of a human face on it. Mr. Stopes read a short note on this at the British Association Meeting at York, 1881 (see Report, p. 700). The carving has not been generally accepted as conclusive by all geologists and anthropologists in England, but some French anthropologists have done so. It is mentioned in Keane's "Ethnology," p. 78. Mr. Stopes considered that the carving suggested pre-Glacial man;[1] he was the first to set to work to disprove or verify it, and it thus determined the direction of his later researches. He took a house near the gravel-pits of Swanscombe, where he made many interesting discoveries, notably that of the association of Palæolithic implements in a sand-bed there with *Neritina fluviatilis* and other extinct species of shells (see his paper in the Journ. Anthrop. Inst., xxix, p. 302). He has collected an enormous number of stone tools, chiefly Palæolithic. His first paper on "The Salting Mounds of Essex" was read before the Essex Antiquarian Society, Dec. 20th, 1884, and was published in the *Essex Naturalist*, April and May, 1887. He read many papers

[1] [It must be borne in mind that the drawing on the shell from the Crag of Essex is open to the same objection as is the cut bone of a Cetacean from an Italian Tertiary deposit, also attributed to man's handwork, namely, that *both deposits are marine*.—EDIT.]

before the Anthropological Section of the British Association and several before various Geological and Literary Societies.

He wrote some articles and reviews for the *Athenæum* and other Journals. His enthusiasm kindled interest in his researches among all he met, friends or workmen alike. When the complaint from which he suffered was found to be consumption, he was ordered to try open-air treatment, and he would go nowhere else than to the scene of his researches. He was buried near Old Swanscombe Church on December 10th, and the workmen of the village feel they have lost a friend.

ALFRED VAUGHAN JENNINGS,

Assoc. R. S. Mines, F.L.S., F.G.S.

Born April 17, 1864. Died January 11, 1903.

Alfred Vaughan Jennings was born at Hampstead, and educated at St. Paul's School. He matriculated at London University 1877, and entered as a student at the Royal School of Mines under Professor Huxley, etc., where he was bracketed first in Advanced Zoology with Martin F. Woodward in 1885, and received the Edward Forbes Medal and prize of books for Biology in that year. He was for three years Demonstrator in Geology with Professor Judd, F.R.S., undertaking at the same time to instruct privately, in his own laboratory in Chancery Lane, a class of students in Biology, preparing for the B.Sc. London University Examination. He also taught occasional classes in Botany at the Birkbeck Institution.

It was the passionate earnestness with which he taught and inspired these young men which first betrayed his abnormally nervous temperament and weak heart. The work of teaching, for which he inherited a genius, had in consequence to be given up. Six months were then spent beneficially in a voyage and visit to New Zealand. On his return in 1890 he undertook the arrangement of the new Museum about to be opened at Eton College; and after the death of Dr. P. Herbert Carpenter he was offered by Dr. Warre, Head Master of Eton College, one of Dr. Carpenter's classes, in addition to the permanent care of the Museum. This he was compelled to decline, as the doctors still forbad his teaching, and residence at Eton had already proved mischievous to his health.

In 1892 he took charge of the Museum then opened at Whitechapel. In 1895 he removed to Dublin, where for three or four years he assisted Professors Cole and Johnson with the geological and botanical classes at the Royal College of Science. But teaching had again to be abandoned. He subsequently went to Davos Platz, and later to Bad Nauheim, from which places he sent papers to the Geological Society and to this Magazine, viz. :—

Jennings, A. V.—"On the Courses of the Landwasser and the Landquart": Geol. Mag., 1899, pp. 259–270, with three illustrations.

——— "The Geology of the Davos District": Proc. Geol. Soc., May 10, 1899; Geol. Mag., 1899, pp. 326–327; Quart. Journ. Geol. Soc., 1899, vol. lv, pp. 381–412, pls. xxvi and xxvii, map, and section.

——— "The Geology of Bad Nauheim and its Thermal Salt-Springs": Geol. Mag., 1900, pp. 349–366, with six illustrations.